

**Research Activity AR.06**

**APPLICATION OF FUZZY LOGIC-NEURAL  
NETWORK BASED REINFORCEMENT LEARNING  
TO  
PROXIMITY AND DOCKING OPERATIONS**

**Deliverable D2  
Report on Attitude Control Results**

submitted  
to

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## **1.0 Introduction :**

As part of the RICIS activity, the reinforcement learning techniques developed at Ames Research Center are being applied to proximity and docking operations using the Shuttle and Solar Max satellite simulation. This activity is carried out in the software technology laboratory utilizing the Orbital Operations Simulator (OOS). This report is deliverable D2 Attitude Control Results and provides the status of the project after four months of activities and outlines the future plans. In section 2 we describe the Fuzzy-Learner system for the attitude control functions. In section 3, we provide the description of test cases and results in a chronological order. In section 4, we have summarized our results and conclusions. Our future plans and recommendations are provided in section 5.

## **2.0 Fuzzy Learning System Configuration :**

The Fuzzy-Learner system is also referred as an Approximate Reasoning based Intelligent Control architecture as shown in fig. 1. There are two neural networks as depicted in fig.2. The first neural network is action selection network that includes the attitude controller, the second neural network is the action evaluation network that utilizes the failure signal to generate a reinforcement for the action. In absence of failure signal it generates internal reinforcement. Finally, the ARIC architecture utilizes stochastic process to take an action that is consistent with the fuzzy control output.

### **2.1 Input and Output Variables**

The input variables for the fuzzy controller are angle error and rate error. The universe of discourse for the variables is from -10.0 to 10.0 degrees and degrees per second. For the neural network inputs, these must be scaled to a value between -1.0 and 1.0. If we scale the variables using the universe of discourse, the scaled angle error and rate error remain very close to zero and there is no variation in the input. The neural network can not properly learn the behavior. So the scaling of the input is changed to provide variation between -0.5 and 0.5. This is accomplished using deadband (DB) values. When the inputs are scaled using  $2 \times \text{DB}$  then the input variations allow for proper training. The failure criteria has also been changed to reflect the usage of the DB. The angle error should not go out of the universe of discourse. Currently, if the angle error is more than  $1.2 \times \text{DB}$  then there is a failure. This criteria seems to work very nice for reinforcement strength.

Besides angle error and rate error, bias is another input into the fuzzy controller. Typically, bias is set at 0.5, and is used consistently. If the bias is set to zero, then, the fuzzy controller does not function at all. Because of max-min inferencing, zero bias always provides a zero belief value for the left hand side of the rule. As a result no rule fires and the fuzzy controller output is always zero. If the output is between -1.0 and 1.0, then, no jets fire and controller does not control the attitude. If the bias is set to 1.0, then, the fuzzy controller output is

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# ARIC Architecture

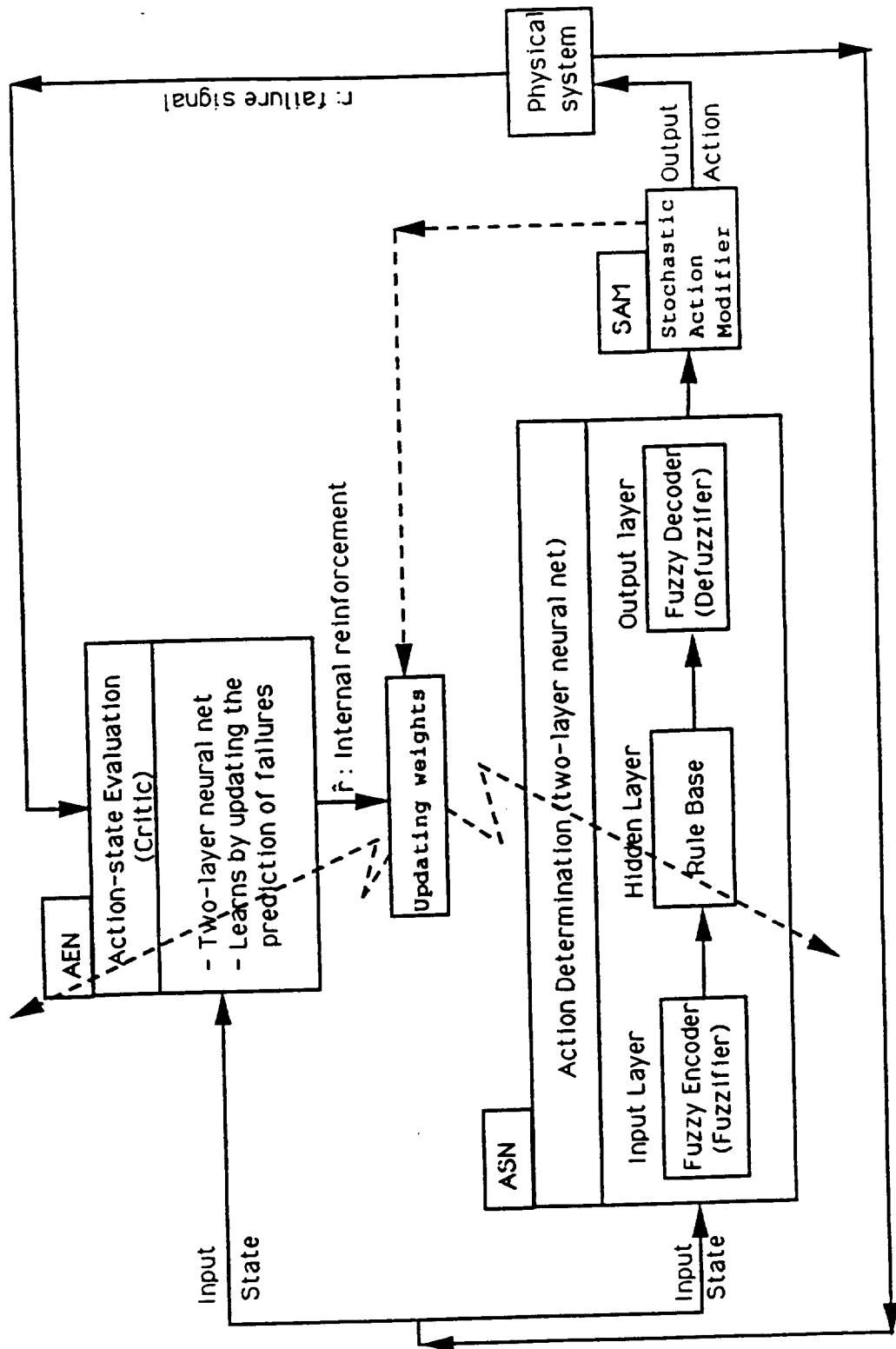


Fig 1 ARIC Architecture



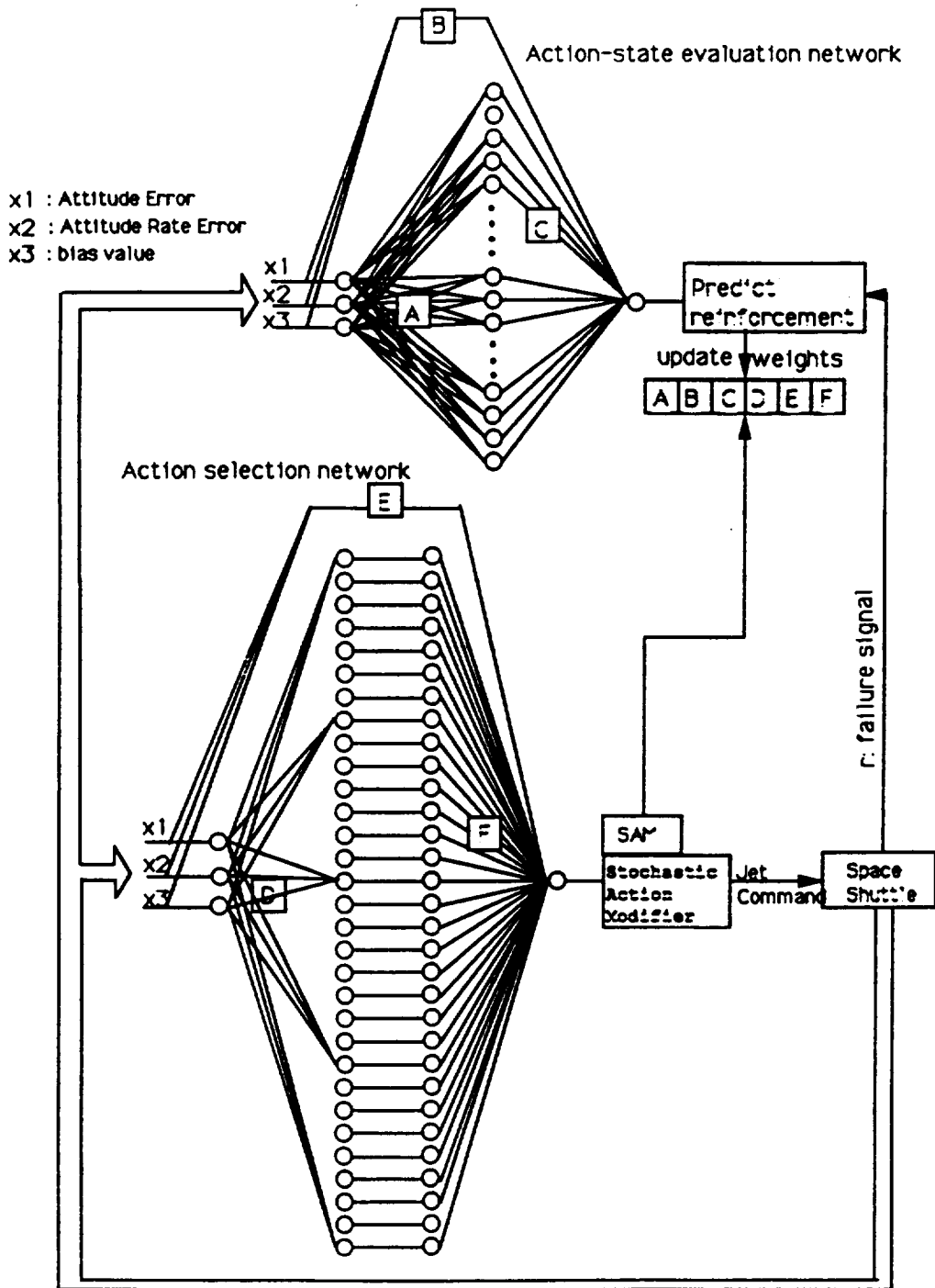


Fig. 2 ARIC applied to Space Shuttle attitude control

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# ATTITUDE CONTROL RULEBASE

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Attitude Error Rate	PB				PM	PS	PM	PM
	PM				PM	PS	PM	PM
	PS				PS	PS	PS	PS
	ZO	NS	NS	NS	ZO	PS	PS	PS
	NS	NS	NS	NS	NS			
	NM	NM	NM	NS	NM			
	NB	NM	NM	NS	NM			





always more than what is wanted. Inputs have no meaning so far as rules are concerned. The output of the fuzzy controller is the same for all values of the inputs. Again, the fuzzy controller does not function properly. Thus, the best value seems to be 0.5, where, the bias plays equal importance for the range of inputs. It is an adhoc choice but seems to work fine for the fuzzy controller. We have performed several test cases with different values of the bias, and have determined that the value of 0.5 provides the best performance. So we are continuing with that choice. We discussed this situation with Ames Research Center and their opinion was the same. They emphasized the use of bias, and asked us not to use anything but 0.5.

## 2.2 Defuzzification Method

We analyzed the defuzzification method implemented in the fuzzy learning system. This method is different from the centroid defuzzification method. To achieve the consistent fuzzy controller output (as we had previously achieved in our attitude control tests) either we had to implement the proper centroid defuzzification method or change the relationship between the fuzzy control output and jet firing scheme. Currently, in attitude control, jets are fired when the output of the fuzzy control exceeds 1.0 or is less than -1.0, and no jets are fired when the output is between these two values. Based on our analysis, we concluded that the best solution for us is to change the relationship between the output and jet firing. That way we will not be modifying the method used by Dr. Berenji. Our analysis showed that the jet firing criteria should be changed to -0.5 and +0.5 of the fuzzy controller output rather than -1.0 and +1.0 to essentially provide the same effect as the centroid defuzzification method. We have changed the mapping of the output of the fuzzy controller to RHC input in the simulation. Our results showed that the fuzzy controller is performing in the same way as it used to in our earlier set up.

## 2.3 Exponent Normalization in Sigmoid

The formula for the sigmoid function is as follows.

$$Z_i = 1 / ( 1 + \exp ( -1.0 * \text{sum}_i ) )$$

where the sum is the summation over  $j$  with  $x_j * d_{ij}$  for each rule  $i$ , or the summation over  $i$  with  $F_i * Z_i$  term for each rule. The first is the summation over input parameters, and the second is the summation over all rules. We have changed the summation to normalize for the number of rules i.e. the sum over  $F_i * Z_i$  is divided by the number of rules.

## 2.4 Learning Rate in exponent of Sigmoid

The term 1.0 in the sigmoid formula is the learning rate of the neural network. This rate can be changed to enhance the learning from the errors. When this

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term is high, the learning rate is high and thus the output of the sigmoid almost becomes binary. If this term is low then the output of the sigmoid is responsive according to the sum and there is considerable variation in the updates of the weights.

## 2.5 Momentum in Weight Updates

The update of the D's and F's in the neural networks are given by

$$\Delta D = \rho_h * \hat{r} * Z_i * (1 - Z_i) * \text{Unusualness}$$

$$\Delta F = \rho * \hat{r} * \text{Unusualness} * Z_i$$

The terms  $\rho$  and  $\rho_h$  are called momentum and are used to preserve the direction of learning. These can be changed to alter the performance of the learning system. We have changed the  $\rho_h$  to 0.8 from 0.2 in our final configuration.

## 2.6 Modified Formula for Weight Updates

We have modified the formulas for updating the weights D's and F's in the action selection network to reflect the firing strengths of the rules. These new formulas are as follows.

$$\Delta D = \rho_h * \hat{r} * Z_i * (1 - Z_i) * \text{Unusualness} * w_i$$

$$\Delta F = \rho * \hat{r} * \text{Unusualness} * Z_i * w_i$$

## 3.0 Description of Test Cases :

An attitude hold test case was set up with the shuttle in its normal orbit during its mission. The pitch attitude of the shuttle was set at 45 degrees in the local vertical local horizontal coordinate system. Because of the gravity gradient torques, the shuttle pitch rate starts increasing resulting in an increase in the pitch attitude. As soon as the attitude error (difference between the desired attitude and the current attitude ) goes beyond the deadband limit, the fuzzy controller will initiate jet firing. Two neural networks are learning during each cycle and adjusts the parameters as required.

The test case was setup to run up to 1000 seconds so there will be at least three attitude firings. For debug and analysis purposes, we initially performed the test case for only 30 seconds. Later, we extended the test case to 1000 and 100,000 seconds to understand the learning process and evaluate the performance of the fuzzy controller and neural networks. Plots for all 16 test case are included in Appendix B. So far we have performed many test cases with modifications in

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the source code and changes in the learning parameters. Results and our important modifications are described chronologically in this section.

a. We randomized the D's in the interval [0.9 and 1.0] in the initialization routine, and performed the test case again. Plots of the F and D parameters again showed the same variation. When the variation in the D's was the same, we analyzed the sigmoid function. It showed that the exponent becomes very large, and in that case, the variations in the D's do not translate into any further variations in the output of the sigmoid function or the F's. The sigmoid function is too steep, and the exponent is too large. The best solution for this would be to normalize the sum according to the number of rules, and number of inputs. Wherever the exponent is summed over inputs X's, the normalization should be obtained by using the number of inputs. If the sum is over the number of rules, then, the normalization should be over the number of rules.

b. We normalized the sums in all sigmoid functions and performed the test case again. Results of this test case did not show any variations in the behavior of the D and F parameters. All F's were still the same and D's did not change at all. Our analysis showed that if the sigmoid function is too steep then randomizing D's will not change the behavior of F's. Thus, we concluded that the F's must also be randomized to see how the learning for each individual rule progresses.

c. Initial values of the F's were randomized within the interval [0.9, 1.0] in the initialization routine. Thus, both, D's and F's are randomized with correct implementation for computing the 'push' variable. The test case was performed again and the plots of the D's and F's did not show any variations. All F's varied in the same manner and all D's formed a triplet pair. Implication of these results is that the neural networks in the learning routine behave as a neuron rather than as a neural network. The generalization from a single neuron formula to neural network has not occurred properly.

We thought that this might be due to the fact that the sigmoid function is too steep and we must change the learning rate in the exponent to flatten out the sigmoid function. Thus, the output of the sigmoid will not be always a constant value.

d. The learning rate in the exponent was changed from 1.0 to 0.2 to flatten out the response of the sigmoid. The summation over the inputs were normalized using the number of input parameters and the sum over the rules was normalized using the total number of rules. The test case was performed again and plots did not show any improvements. We changed the learning rate to 0.1 and performed the test case to find out that there is no change in the results. All F's and D's vary in the same manner.

We analyzed the sigmoid function using the spreadsheet program Excel, and realized that the normalization reduces the steepness of the sigmoid function. However, lowering the learning rate in the exponent makes it steep again, and thus, the two changes negates each other and we have made no improvement in the performance. We analyzed the sigmoid behavior with various learning

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rate and found out that the learning rate should be 1.0 and normalization should be done only for the number of rules.

e. The code was changed to normalize SUM in the exponent for the number of rules only and not for individual input variations. The learning rate was reset at 1.0 and the test was performed. Plots did not show any improvement in the behavior of F's and D's. We argued that the variation in the D's is not enough to appreciably differ the F's parameters for each rule. When we analyzed the update of the D's, we learned that there is a term  $Z^*(1-Z)$  in the formula where Z is the output of the sigmoid. We used Excel program to understand the behavior of this term and realized that term further washes out any variations in the sigmoid output. Thus, there will not be any variations in the D's even if the sigmoid is flat. The update formula has a constant parameter  $\rho_h$  called momentum. This is set at 0.2 in the test case. If the output of the sigmoid is 0.5, then the term  $Z^*(1-Z)$  has maximum value of 0.25. As the output increases to 1.0 or decreases to 0.0, then the term reduces to 0.0. To provide the maximum effect at the sigmoid output of 0.5, we increased the value of  $\rho_h$  to 0.8, because the term has maximum value of 0.25. Our intention is to compensate for the effect of the term.

f. The value of  $\rho_h$  was modified to 0.8 from its default value of 0.2 and the test was performed again. We did not find any change in the result. We looked at the effect of the bias term again. The fuzzy controller has no bias term but neural networks still include it in the calculations. The bias was set at zero to take it out of the neural networks, and the test was performed again. There is no change in the results. The D's and F's still vary the same way and no special learning for each rule.

We started looking at the formula that updates the F's. In that formula, three terms,  $\rho$ , unusualness and  $R\text{-hat}$ , are the same for each rule, because these terms are set for a given cycle. The only term that varies for individual rules is the output  $Z_i$  of the sigmoid. Now  $Z_i$  may vary from rule to rule, however, the variation is very small. Further, it never goes to zero for a rule that is not fired. There is no mechanism to indicate that the rule is not fired therefore its strength must not be changed. It is a common sense that the strength of a rule does not change if it is not used. Thus, it is realized that a term is required to mention this fact. The only suitable term that indicates the usage of the rule is the belief value  $w_i$  from the left hand side of the rule. Thus, the formula for the update of the F's is changed to include  $w_i$  as a multiplier. If the rule is not fired then its  $w_i$  value is zero, and thus, the F parameter for that rule at that time will not change. If the  $w_i$  value for a rule is 1.0, then, maximum change in the F will occur. Now the formula for the update of the F's looks correct and consistent with our human experience.

g. The code was modified to update F's with  $w_i$ 's, so each rule has an update related to its firing strength. If the rule is not fired, then, its F will not have an update. The test was performed for 1000 seconds, and the plots this time showed the expected results. We have finally achieved the learning for each individual rule, and the F's vary in different manner for each rule. If a rule is not

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fired, then, there is no change in the F value. If a rule fires with maximum strength, then, the F changes maximum possible at that time according to input parameters.

We performed a 100,000 second attitude hold, and the plots show that the F's stabilize at constant values. Each F varies according to the input and rule firing strength, but finally settles at about 50,000 seconds to a constant value. This is exactly a desired behavior, if the fuzzy learner is properly learning each rule.

We now argued that the D's should have the same multiplier for individuality of the rules. For a given set of inputs, the only thing that changes the behavior is the D's which are multipliers within a rule. Thus, these should also be updated using the firing strength of the rule. If the rule does fire, then, its D's should not be updated.

h. The code was modified to update the D's to reflect the firing strength of the rules. The test was performed for 1000 second to find out the results for a short period, and then a 100,000 seconds test was performed to obtain stable values of the D's and F's for the rule base.

Finally, to make sure that the new formulas for the updates of the D's and F's work for different attitudes, a 100,000 seconds test is performed with different initial attitude. The results are very very encouraging for the fuzzy learner performance.

#### **4.0 Results and Conclusions :**

Defuzzification Method used in the fuzzy-learner system can be equivalent to the centroid method with appropriate changes in the interpretation of the output.

We analyzed the performance of the fuzzy controller further, and especially in light of the defuzzification scheme. We quickly learned that the bias is not serving any purpose in the fuzzy controller. It is rather constraining the performance. We discussed this situation further with Ames. After several discussions, we both are convinced that the bias term is not required in the fuzzy controller. However, it is required in the learning neural network and thus we must keep it in the calculations. We have removed bias from the fuzzy controller but not from learning neural network code. Our new results have shown that there is no need to use bias as input in the fuzzy controller as well as neural networks.

Learning Rate in exponent of Sigmoid should not be changed from 1.0 because it is providing a better performance with normalization. Furthermore the exponent should be normalized for the number of rules only and not for the number of inputs.

The weights D's and F's need to be randomized initially for the Action Selection Network. Updating the weights of Action Selection Network using the firing



strength of the rule achieves proper variation and learning for that rule. Otherwise there is no variation for D's and F's and thus one neuron can do the job. Because of new formulas, the F's and D's get updated as expected. These formulas seem to work according to our experience and expectations. No such change is warranted for Action Evaluation Network update, because there is no need to tie the number of rules in Fuzzy Controller to number of nodes in NN

Failure criteria is mission dependent and must be changed for each mission objective. For example, the attitude hold and attitude maneuvers will require different failure criteria.

Momentum in the update of D's must be changed to 0.8 to account for the effect of  $Z^*(1-Z)$  in the update formula.

## **5.0 Future Plans :**

Based on our results we are recommending two smaller tasks for the attitude control performance. These tasks are to :

- a. Compare performance of Fuzzy-Learner system with the fuzzy attitude controller for fuel usage during representative mission scenario. This comparison will require to change the code so that the learning can be turned off.
- b. Include fuel usage in the failure criteria so that the Fuzzy-Learner can learn how to save fuel during operations. This will result in operational efficiency for mission operations and adapting to changing environment..

For the overall project we plan to continue little more testing of the fuzzy learning algorithms utilizing the attitude hold test case in the orbital operations simulator. Emphasis during this activity is to ensure that the algorithms perform properly and learning by the neural networks in ARIC architecture is achieved in a satisfactory manner. Then we will switch to other attitude control tests such as attitude maneuver, rate hold and rate maneuver. We will perform these tests with proper perturbations typically present during the orbital operations.

As soon as we complete testing the attitude controller with learning, we will implement the translational controller in the simulation and perform proximity operations test cases. Currently we plan to perform v-bar, r-bar, fly around and station-keeping test cases as we have performed these test cases to check out designs of our translational controller. Finally, we will set up a test case that will simulate docking operations. In this test case, the shuttle will approach the solar max satellite from 50 feet to 2 feet and hold the relative orientation for a specified time at the final distance so that the grappling task can be performed.



## **Appendix A. Final Source Listing of Fuzzy Learning Modules**

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```

#include <stdio.h>
#include <math.h>
#include <sys/types.h>

/* EXTERNAL DATA STRUCTURE DEFINITION */
#include "../orb_fuzzy/learn_cycle.h"
int counter=0;
#define max(x,y) ( (x >= y) ? x : y )
#define min(x,y) ( (x < y) ? x : y )
#define Gamma 0.9
#define Beta 0.2
#define Beta_h 0.05
#define Rho 1.0
/* 1 July 92 Change Rho_h from 0.2 to 0.8 */
#define Rho_h 0.8
#define Rho1 2.0
#define Rho_h1 0.4
extern double sgn();
extern double exp();
extern double rnd();

learn_cycle(L)
LEARN_CYCLE * L; /*IN : */
{
    int i,il, j, k;
    double match(), calculate_z_array();

    double temp ;

    /* CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
    /* 11 March 1992 - Alter scaling */
    /* CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
    /* L->x[0] = L->Phi/20.0; */
    /* L->x[1] = L->Phi_dot/4.0; */
    /* CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
    /* 08 April 1992 - Alter scaling */
    /* CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
    /* L->x[0] = L->Phi/10.0; */
    /* L->x[1] = L->Phi_dot/2.0; */
    /* CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
    L->x[0] = L->Phi ;
    L->x[1] = L->Phi_dot * 10.0 ;
    /* CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
    /* 08 April 1992 - Alter Bias */
    /* CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
    /* L->x[2] = 1.00 ; */
    /* CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
    /* 15 April 1992 - Alter Bias to 0.5 */
    /* CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
    /* 1 July 1992 - Alter Bias to 0.0 */
    /* CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
    L->x[2] = 0.0 ;

    L->failure = 0;

    /* Set up and evaluate the failure criteria */
    if ( (fabs(L->Phi) > 0.7) || (fabs(L->Phi_dot) > 0.07) )
        L->failure = -1.;

    /* output: state evaluation */

    for (i = 0; i < 31; i++)

```





```

{
    L->sum = 0.0;
    for(j = 0; j < 3; j++)
    {
        L->sum += L->a[i*3+j] * L->x_old[j];
    }
    /*CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
    CC JUNE 12 , 1992 - Change to "learning speed"      CC
    CC L->y[i] = 1.0 / (1.0 + exp(-1.0 * L->sum));      CC
    CC JULY 1 , 1992 - Change to "learning speed" 1.0 CC
    CC L->y[i] = 1.0 / (1.0 + exp(-0.1 * L->sum/3.0)); CC
    CC JULY 1 , 1992 - Normalize For Rules Only      CC
    CC L->y[i] = 1.0 / (1.0 + exp(-1.0 * L->sum/3.0)); CC
    CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
    L->y[i] = 1.0 / (1.0 + exp(-1.0 * L->sum));
}
L->sum = 0.0;
for(i = 0; i < 31; i++)
{
    L->sum += L->c[i] * L->y[i];
}
L->sum1 = 0.0;
for ( j = 0; j < 3; j++)
{
    L->sum1 += L->b[j] * L->x_old[j];
}
L->v = L->sum + L->sum1;

/* output: action */
for(i = 0; i < 31; i++)
{
    il=i;

    L->w[i] = match(il,L);
    L->z1[i] = calculate_z_array(il,L);
}
L->sum1 = 0.0;
L->denom = 0.0;
for(i = 0; i < 31; i++)
{
    L->sum1 += L->w[i] * L->z1[i] * L->f[i] ;
    L->denom += L->w[i]*L->f[i] ;
}

/* JUNE 9, 1992 - CORRECTION !!! */
/* Add test for denom very small compared to sum1 - no rule firing zone */
L->push = (1000.0*fabs(L->denom)<fabs(L->sum1)) ? 0.0 : L->sum1/L->denom ;

/* output: action computations completed */
for(i = 0; i < 31; i++)
{
    L->sum = 0.0;

    for (j = 0; j < 3; j++)
        L->sum += L->d[i*3+j] * L->x_old[j];

    /*CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
    CC JUNE 12 , 1992 - Change to "learning speed"      CC
    CC L->z[i] = 1.0 / (1.0 + exp(-1.0 * L->sum));      CC
    CC JULY 1 , 1992 - Change to "learning speed"      CC
    CC L->z[i] = 1.0 / (1.0 + exp(-0.1 * L->sum/3.0)); CC

```



```

CC JULY 1 , 1992 - Normalize For Rules Only      CC
CC L->z[i] = 1.0 / (1.0 + exp(-1.0 * L->sum/3.0)); CC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC*/
    L->z[i] = 1.0 / (1.0 + exp(-1.0 * L->sum));
}
L->sum2 = 0.0;
L->sum3 = 0.0;

for(i = 0; i < 3; i++)
    L->sum2 += L->e[i] * L->x_old[i];

for (i=0;i < 31; i++)
    L->sum3 += L->f[i] * L->z[i];

/*CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CC JULY 1 , 1992 - Change Normalize of sum4      CC
CC L->sum4 = L->sum3 + L->sum2;                      CC
CC JULY 1 , 1992 - Normalize of sum3 by # rules  CC
L->sum4 = L->sum3 / 31.0 + L->sum2 / 3.0 ;
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC*/
L->sum4 = L->sum3 / 31.0 + L->sum2 ;

/*CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CC JUNE 12 , 1992 - Change to "learning speed"    CC
CC L->p = 1.0 / (1.0 + exp(-1.0 * L->sum4));          CC
CC JULY 1 , 1992 - Change to "learning speed" 1.0 CC
CC L->p = 1.0 / (1.0 + exp(-0.1 * L->sum4/34.0)); CC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC*/
    L->p = 1.0 / (1.0 + exp(-1.0 * L->sum4));

/* CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
/* 15 April 1992 - Use temp variable - not push */
/* CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC */
/* L->push = (rnd() <= L->p) ? L->push : -L->push; */
/* L->unusualness = (L->push > 0) ? 1.0 - L->p : -L->p; */
temp = (rnd() <= L->p) ? L->push : -L->push;
L->unusualness = (temp > 0) ? 1.0 - L->p : -L->p;

/* using new input values and unmodified weights. */
/* Use y_new and v_new so not to destroy y and v. */
for(i = 0; i < 31; i++)
{
    L->sum = 0.0;
    for(j = 0; j < 3; j++)
    {
        L->sum += L->a[i*3+j] * L->x[j];
    }
}
/*CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CC JUNE 12 , 1992 - Change to "learning speed"    CC
CC L->y_new[i] = 1.0 / (1.0 + exp(-1.0 * L->sum)); CC
CC JULY 1 , 1992 - Change to "learning speed"    CC
CC L->y_new[i] = 1.0 / (1.0 + exp(-0.1 * L->sum/3.0)); CC
CC JULY 1 , 1992 - Do Not Normalize sum          CC
CC L->y_new[i] = 1.0 / (1.0 + exp(-1.0 * L->sum/3.0)); CC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC*/
    L->y_new[i] = 1.0 / (1.0 + exp(-1.0 * L->sum));
}
L->sum = 0.0;
L->sum1 = 0.0;
L->sum2 = 0.0;

for(j = 0; j < 3; j++)
    L->sum1 += L->b[j] * L->x[j];

```



```

for(i = 0; i < 31; i++)
    L->sum2 += L->c[i] * L->y_new[i];

L->sum = L->sum1 + L->sum2;
L->v_new = L->sum;

/* action evaluation */
if (L->failure)
    L->r_hat = L->failure - L->v;
else
    L->r_hat = L->failure + Gamma * L->v_new - L->v;

/* modification and update to parameters */

for(i = 0; i < 31; i++)
{
    L->factor1 = Beta_h * L->r_hat * L->y[i] * (1.0 - L->y[i]) * sgn(L->c[i]);
    L->c[i] += Beta * L->r_hat * L->y[i];

    for(j = 0; j < 3; j++)
    {
        L->a[i*3+j] += L->factor1 * L->x_old[j];
    }
}

for(i = 0; i < 3; i++)
    L->b[i] += Beta * L->r_hat * L->x_old[i];

for(i = 0; i < 31; i++)
{
/*CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CC 7 July, 1992 : Weight updates of D's by rule firing strength CC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC*/
    L->factor2 = Rho_h * L->r_hat * L->z[i] * (1.0 - L->z[i]) * sgn(L->f[i]) * L->unus
ualness * L->w[i] ;

    for(j = 0; j < 3; j++)

        L->d[i*3+j] += L->factor2 * L->x_old[j];

}

for(i = 0; i < 31; i++)
{
/*CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CC July 2, 1992 : Include Rule Firing Weight in F update CC
CC L->f[i] += Rho * L->r_hat * L->unusualness * L->z[i]; CC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC*/
    L->f[i] += Rho * L->r_hat * L->unusualness * L->z[i] * L->w[i] ;
}

for(i = 0; i < 3; i++)
{
    L->e[i] += Rho * L->r_hat * L->unusualness * L->x_old[i];
}

L->x_old[0] = L->x[0];
L->x_old[1] = L->x[1];
L->x_old[2] = L->x[2];
}
/*****/

```



```
double sgn(x)
```

```
double x;
```

```
{
    if (x < 0.0)
        return (-1.0);
    else if (x > 0.0)
        return (1.0);
    else
        return (0.0);
}
```

```
/* zero_one function returns 0 for negative numbers
```

```
1 for values > 1
```

```
x for values between 0 and 1 */
```

```
double zero_one(x)
```

```
double x;
```

```
{
    if (x < 0) return (0.0);
    else if (x > 1) return (1.0);
    else return (x);
}
```

```
/****** Membership Function for Phi *****/
```

```
double nb1(x)
```

```
double x;
```

```
{
    return(min( max((-2-x)/3 , 0.0 ), 1.0 ));
}
```

```
double nm1(x)
```

```
double x;
```

```
{
    if (x <= -2.5) return (min( max(( x+4)/1.5 , 0.0 ), 1.0 ));
    else return (min( max((-x-1)/1.5 , 0.0 ), 1.0 ));
}
```

```
double ns1(x)
```

```
double x;
```

```
{
    if (x <= -1.0) return (min( max( x+2.0 , 0.0 ), 1.0 ));
    else return (min( max( -x , 0.0 ), 1.0 ));
}
```

```
double zo1(x)
```

```
double x;
```

```
{
    if (x <= 0) return (min( max( x+1 , 0.0 ), 1.0 ));
    else return (min( max( -x+1 , 0.0 ), 1.0 ));
}
```

```
double ps1(x)
```

```
double x;
```

```
{
    if (x <= 1) return (min( max( x , 0.0 ), 1.0 ));
    else return (min( max( -x+2 , 0.0 ), 1.0 ));
}
```

```
double pm1(x)
```

```
double x;
```

```
{
    if (x <= 2.5) return (min( max(( x-1)/1.5 , 0.0 ), 1.0 ));
    else return (min( max((-x+4)/1.5 , 0.0 ), 1.0 ));
}
```





```
double pb1(x)
double x;
{
    return(min( max(( x-2)/3 , 0.0 ), 1.0 ));
}
/***** Phi_dot Membership Functions *****/
double nb2(x)
double x;
{
    return(min( max((-0.2-x)/.3 , 0.0 ), 1.0 ));
}

double nm2(x)
double x;
{
    if (x <= -.25)    return (min( max(( x+.4)/.15 , 0.0 ), 1.0 ));
    else return (min( max(( -x-.1)/.15 , 0.0 ), 1.0 ));
}

double ns2(x)
double x;
{
    if (x <= -.1)    return (min( max(( x+.2)/.1 , 0.0 ), 1.0 ));
    else return (min( max(( -x/.1) , 0.0 ), 1.0 ));
}

double zo2(x)
double x;
{
    if (x <= 0)    return (min( max(( x+.1)/.1 , 0.0 ), 1.0 ));
    else return (min( max(( -x+.1)/.1 , 0.0 ), 1.0 ));
}

double ps2(x)
double x;
{
    if (x <= .1)    return (min( max(( x/.1) , 0.0 ), 1.0 ));
    else return (min( max(( -x+.2)/.1 , 0.0 ), 1.0 ));
}

double pm2(x)
double x;
{
    if (x <= .25)    return (min( max(( x-.1)/.15 , 0.0 ), 1.0 ));
    else return (min( max(( -x+.4)/.15 , 0.0 ), 1.0 ));
}

double pb2(x)
double x;
{
    return(min( max(( x-.2)/.3 , 0.0 ), 1.0 ));
}

/***** Defuzzification Process with Accel Membership Functions *****/

double nm3(x)
double x;
{
    return(-2-x);
}

double ns3(x)
double x;
{
    return(-2*x);
}

double zo3(x)
```



```
double x;
{
    return(0.0);
}

double ps3(x)
double x;
{
    return(2*x);
}

double pm3(x)
double x;
{
    return(2+x);
}

double match(i,L)
int i;
LEARN_CYCLE *L;          /*IN : */
{
    double temp;
    switch (i) {

        case 0:
            temp =min( zero_one(nbl(L->Phi)*L->d[i*3+0]), zero_one(zo2(L->Phi_dot)*L->d[i*3+1]))
;
/* REMOVE "BIAS" REFERENCE
            temp= min(temp,zero_one(L->x[2]*L->d[i*3+2]));
*/
            return(temp);
        case 1:
            temp=min( zero_one(nbl(L->Phi)*L->d[i*3+0]), zero_one(ns2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
            temp=min(temp,zero_one(L->x[2]*L->d[i*3+2]));
*/
            return(temp);
        case 2:
            temp=min( zero_one(nbl(L->Phi)*L->d[i*3+0]), zero_one(nm2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
            temp=min(temp,zero_one(L->x[2]*L->d[i*3+2]));
*/
            return(temp);
        case 3:
            temp=min( zero_one(nbl(L->Phi)*L->d[i*3+0]), zero_one(nb2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
            temp=min(temp,zero_one(L->x[2]*L->d[i*3+2]));
*/
            return(temp);
        case 4:
            temp=min( zero_one(nml(L->Phi)*L->d[i*3+0]), zero_one(zo2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
            temp=min(temp,zero_one(L->x[2]*L->d[i*3+2]));
*/
            return(temp);
        case 5:
            temp=min( zero_one(nml(L->Phi)*L->d[i*3+0]), zero_one(ns2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
            temp=min(temp,zero_one(L->x[2]*L->d[i*3+2]));
*/
            return(temp);
        case 6:
```



```
temp=min( zero_one(nm1(L->Phi)*L->d[i*3+0]), zero_one(nm2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
return(temp);
case 7:
temp=min( zero_one(nm1(L->Phi)*L->d[i*3+0]), zero_one(nb2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
return(temp);
case 8:
temp=min( zero_one(ns1(L->Phi)*L->d[i*3+0]), zero_one(zo2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
return(temp);
case 9:
temp=min( zero_one(ns1(L->Phi)*L->d[i*3+0]), zero_one(ns2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
return(temp);
case 10:
temp=min( zero_one(ns1(L->Phi)*L->d[i*3+0]), zero_one(nm2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
return(temp);
case 11:
temp=min( zero_one(ns1(L->Phi)*L->d[i*3+0]), zero_one(nb2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
return(temp);
case 12:
temp=min( zero_one(zol(L->Phi)*L->d[i*3+0]), zero_one(pb2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
return(temp);
case 13:
temp=min( zero_one(zol(L->Phi)*L->d[i*3+0]), zero_one(pm2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
return(temp);
case 14:
temp=min( zero_one(zol(L->Phi)*L->d[i*3+0]), zero_one(ps2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
return(temp);
case 15:
temp=min( zero_one(zol(L->Phi)*L->d[i*3+0]), zero_one(zo2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
return(temp);
case 16:
temp=min( zero_one(zol(L->Phi)*L->d[i*3+0]), zero_one(ns2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
```



```
        return(temp);
    case 17:
        temp=min( zero_one(zol(L->Phi)*L->d[i*3+0]), zero_one(nm2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
        temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
        return(temp);
    case 18:
        temp=min( zero_one(zol(L->Phi)*L->d[i*3+0]), zero_one(nb2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
        temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
        return(temp);
    case 19:
        temp=min( zero_one(psl(L->Phi)*L->d[i*3+0]), zero_one(pb2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
        temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
        return(temp);
    case 20:
        temp=min( zero_one(psl(L->Phi)*L->d[i*3+0]), zero_one(pm2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
        temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
        return(temp);
    case 21:
        temp=min( zero_one(psl(L->Phi)*L->d[i*3+0]), zero_one(ps2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
        temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
        return(temp);
    case 22:
        temp=min( zero_one(psl(L->Phi)*L->d[i*3+0]), zero_one(zo2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
        temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
        return(temp);
    case 23:
        temp=min( zero_one(pml(L->Phi)*L->d[i*3+0]), zero_one(pb2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
        temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
        return(temp);
    case 24:
        temp=min( zero_one(pml(L->Phi)*L->d[i*3+0]), zero_one(pm2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
        temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
        return(temp);
    case 25:
        temp=min( zero_one(pml(L->Phi)*L->d[i*3+0]), zero_one(ps2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
        temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
        return(temp);
    case 26:
        temp=min( zero_one(pml(L->Phi)*L->d[i*3+0]), zero_one(zo2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
        temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
        return(temp);
    case 27:
        temp=min( zero_one(pbl(L->Phi)*L->d[i*3+0]), zero_one(pb2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
```





```

    temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
    return(temp);
case 28:
    temp=min( zero_one(pbl(L->Phi)*L->d[i*3+0]), zero_one(pm2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
    temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
    return(temp);
case 29:
    temp=min( zero_one(pbl(L->Phi)*L->d[i*3+0]), zero_one(ps2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
    temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
    return(temp);
case 30:
    temp=min( zero_one(pbl(L->Phi)*L->d[i*3+0]), zero_one(zs2(L->Phi_dot)*L->d[i*3+1]));
/* REMOVE "BIAS" REFERENCE
    temp=min(temp, zero_one(L->x[2]*L->d[i*3+2]));
*/
    return(temp);
}
}

```

```
double calculate_z_array(i, L)
```

```
int i;
```

```
LEARN_CYCLE * L;          /*IN : */
```

```

{
    switch (i) {
        case 0:
            return(ps3(L->w[0]));
        case 1:
            return(ps3(L->w[1]));
        case 2:
            return(pm3(L->w[2]));
        case 3:
            return(pm3(L->w[3]));
        case 4:
            return(ps3(L->w[4]));
        case 5:
            return(ps3(L->w[5]));
        case 6:
            return(pm3(L->w[6]));
        case 7:
            return(pm3(L->w[7]));
        case 8:
            return(ps3(L->w[8]));
        case 9:
            return(ps3(L->w[9]));
        case 10:
            return(ps3(L->w[10]));
        case 11:
            return(ps3(L->w[11]));
        case 12:
            return(nm3(L->w[12]));
        case 13:
            return(nm3(L->w[13]));
        case 14:
            return(ns3(L->w[14]));
        case 15:
            return(zs3(L->w[15]));
        case 16:
            return(ps3(L->w[16]));
        case 17:

```



```
    return(pm3(L->w[17]));  
case 18:  
    return(pm3(L->w[18]));  
case 19:  
    return(ns3(L->w[19]));  
case 20:  
    return(ns3(L->w[20]));  
case 21:  
    return(ns3(L->w[21]));  
case 22:  
    return(ns3(L->w[22]));  
case 23:  
    return(nm3(L->w[23]));  
case 24:  
    return(nm3(L->w[24]));  
case 25:  
    return(ns3(L->w[25]));  
case 26:  
    return(ns3(L->w[26]));  
case 27:  
    return(nm3(L->w[27]));  
case 28:  
    return(nm3(L->w[28]));  
case 29:  
    return(ns3(L->w[29]));  
case 30:  
    return(ns3(L->w[30]));
```

```
}
```

```
}
```



```
#include <stdio.h>
#include <math.h>
#include <sys/types.h>
/* EXTERNAL DATA STRUCTURE DEFINITION */

#include "../orb_fuzzy/learn_cycle.h"

double rnd() /* Returns a floating-point between 0 and 1, including 0. */
{
    /* rand is a number between 0 and 2^31 - 1 */

    return ((double) rand() / (double) (RAND_MAX));
}

set_rnd_weights (L)
LEARN_CYCLE * L;
{
    int i,j;

    for (i = 0; i < 3; i++)
        L->b[i] = rnd() * 0.2 - 0.1;
    for (i = 0; i < 31; i++)
    {
        L->c[i] = rnd() * 0.2 - 0.1;
        L->e[i] = rnd() * 0.2 - 0.1;
        L->f[i] = rnd() * 0.1 + 0.9;
        L->w[i] = 1.0;
    }
    L->x_old[0]= L->x_old[1]= L->x_old[2]=0.0;

    for (j = 0; j < 93; j++)
    {
        L->a[j] = rnd() * 0.2 - 0.1;
        L->d[j] = rnd() * 0.1 + 0.9 ;
    }
}
```

— — — — —

```

/* IDENTIFICATION:      Hana Shehadeh   LinCom Corporation*/
/*                      June 1991       */

```

```

/* PURPOSE:*/
#define RAND_MAX  32767

```

```

typedef struct {

```

```

/*****
/*PARAMETER DECLARATION:          USAGE BY DRIVER MODULES:*/
/*TYPE  VARIABLE[SIZE]          <INOUT> DESCRIPTION*/
/*-----*/

```

```

int      start_state;    /*      <      >          */
int      learn_flag;    /*      <      >          */
int      n1;             /*      <      > counter   */
int      n2;             /*      <      > counter   */
double   Phi;            /*deg    <      > angle error */
double   Phi_dot;        /*deg    <      > rate error  */
double   failure ;      /*      <      >          */
double   x_old[3] ;     /*      <      >          */
double   y_new[31] ;    /*      <      >          */
double   z1[31] ;       /*      <      >          */
double   f1[31] ;       /*      <      >          */
double   e1[31] ;       /*      <      >          */
double   w[31];         /*      <      >          */
double   z[31];         /*      <      >          */
double   f[31];         /*      <      >          */
double   x[3];          /*      <      >          */
double   a[93];         /*      <      >          */
double   d[93];         /*      <      >          */
double   b[3];          /*      <      >          */
double   c[31];         /*      <      >          */
double   e[31];         /*      <      >          */
double   y[31];         /*      <      >          */
double   v_new ;        /*      <      >          */
double   r_hat ;        /*      <      >          */
double   push ;         /*      <      > FORCE APPLIED */
double   unusualness ;  /*      <      >          */
double   sum ;          /*      <      >          */
double   sum1 ;         /*      <      >          */
double   sum2 ;         /*      <      >          */
double   sum3 ;         /*      <      >          */
double   sum4 ;         /*      <      >          */
double   sumd ;         /*      <      >          */
double   factor1 ;      /*      <      >          */
double   factor2 ;      /*      <      >          */
double   factor3 ;      /*      <      >          */
double   denom ;        /*      <      >          */
double   v;             /* failure related parameter */
double   p;             /* failure related parameter */

```

```

} LEARN_CYCLE ;

```





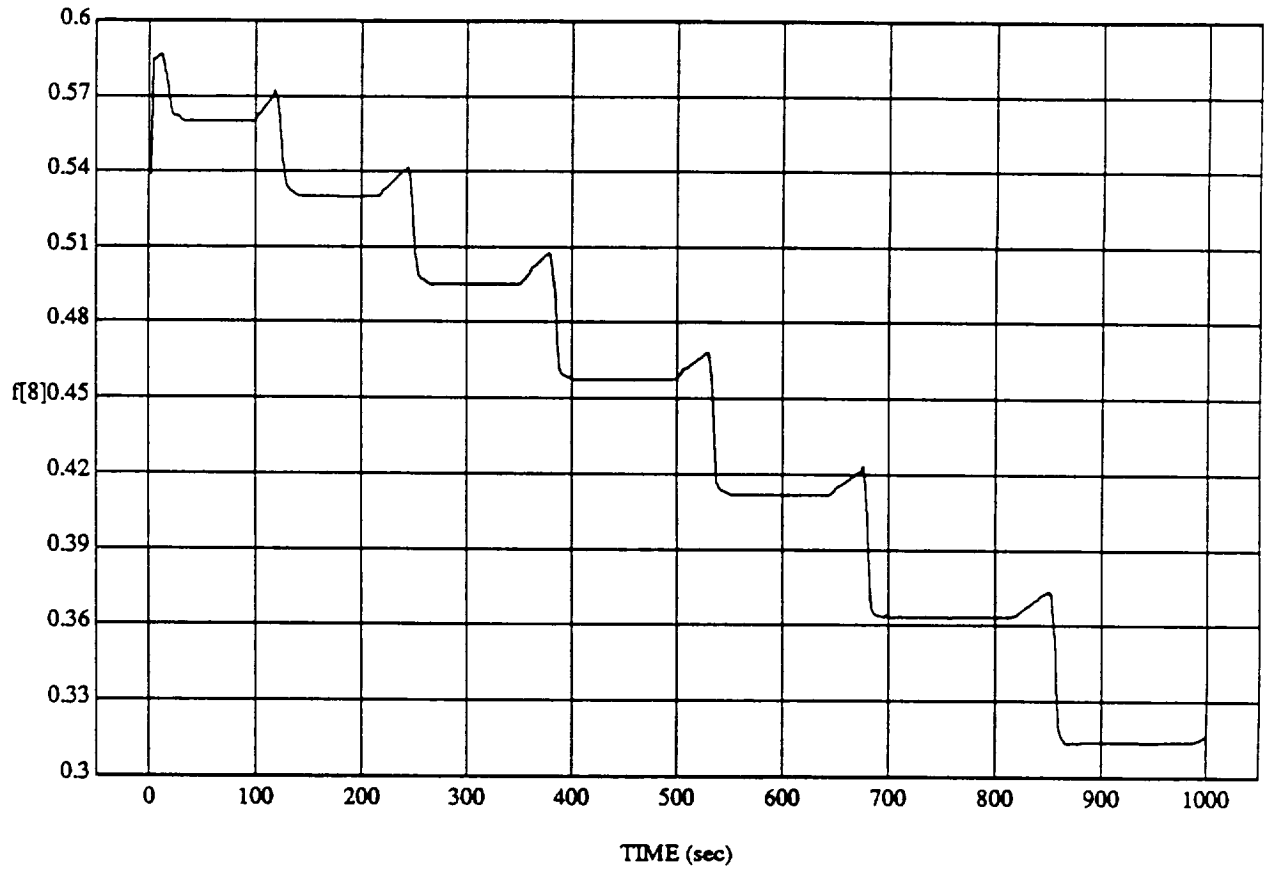
## Appendix B. Plots of Selected Parameters for 16 configurations

1

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[8]$  vs TIME

RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992

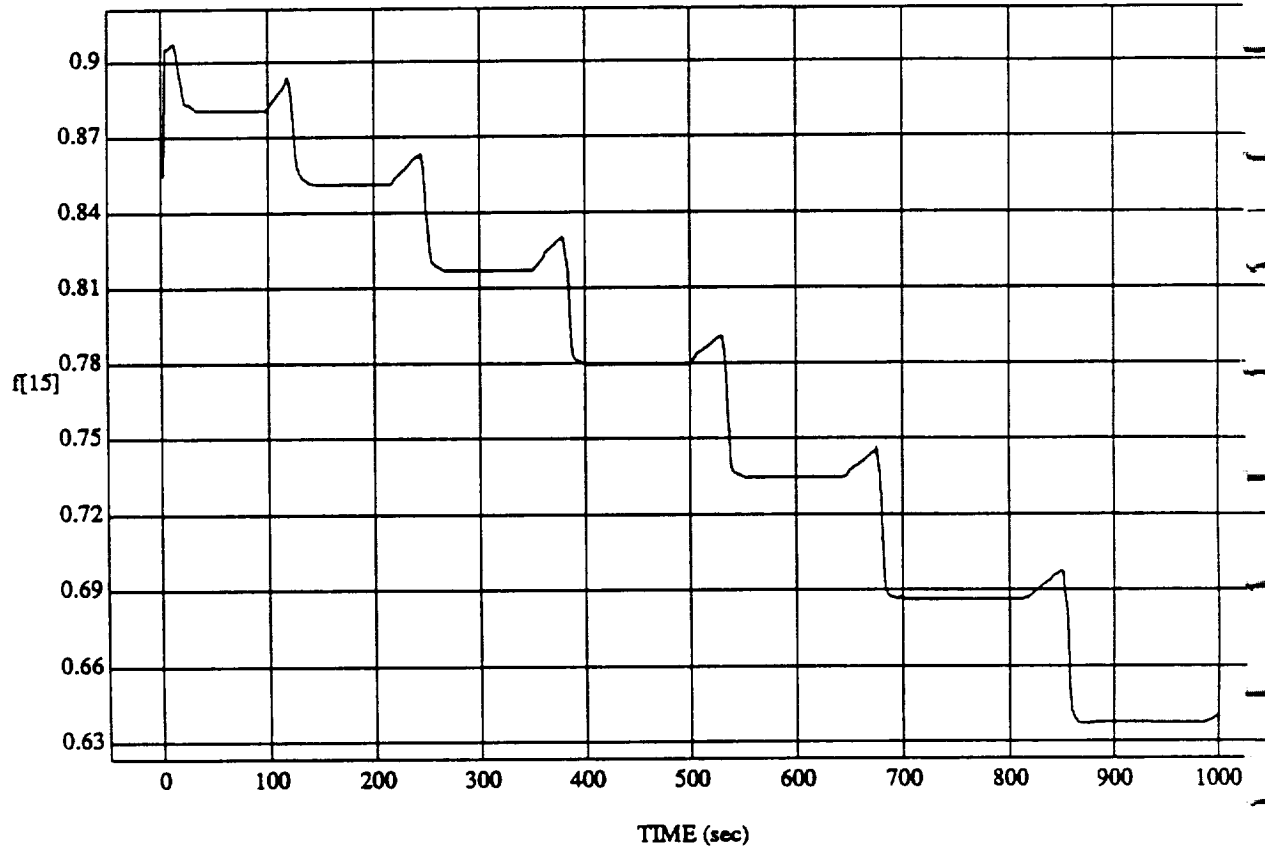


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[15] vs TIME

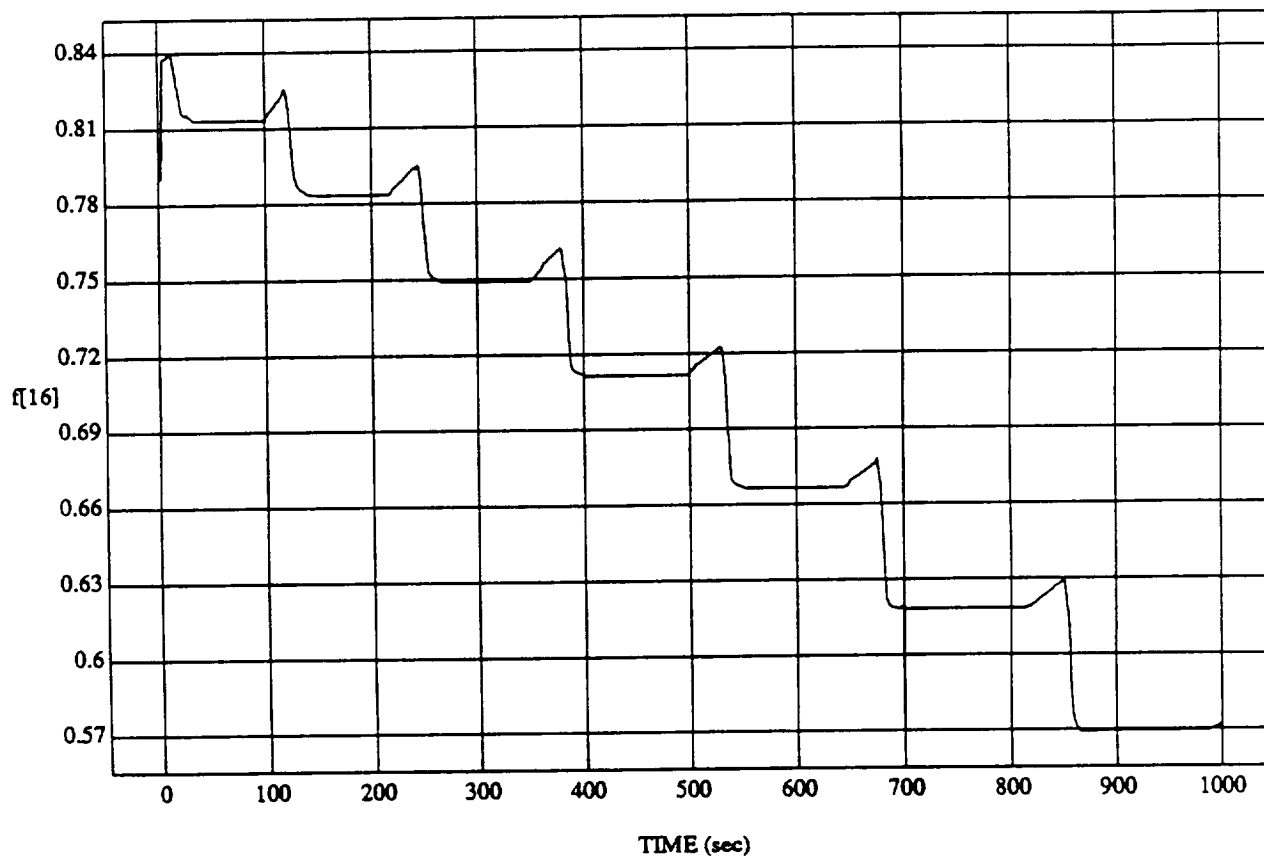
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[16] vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992

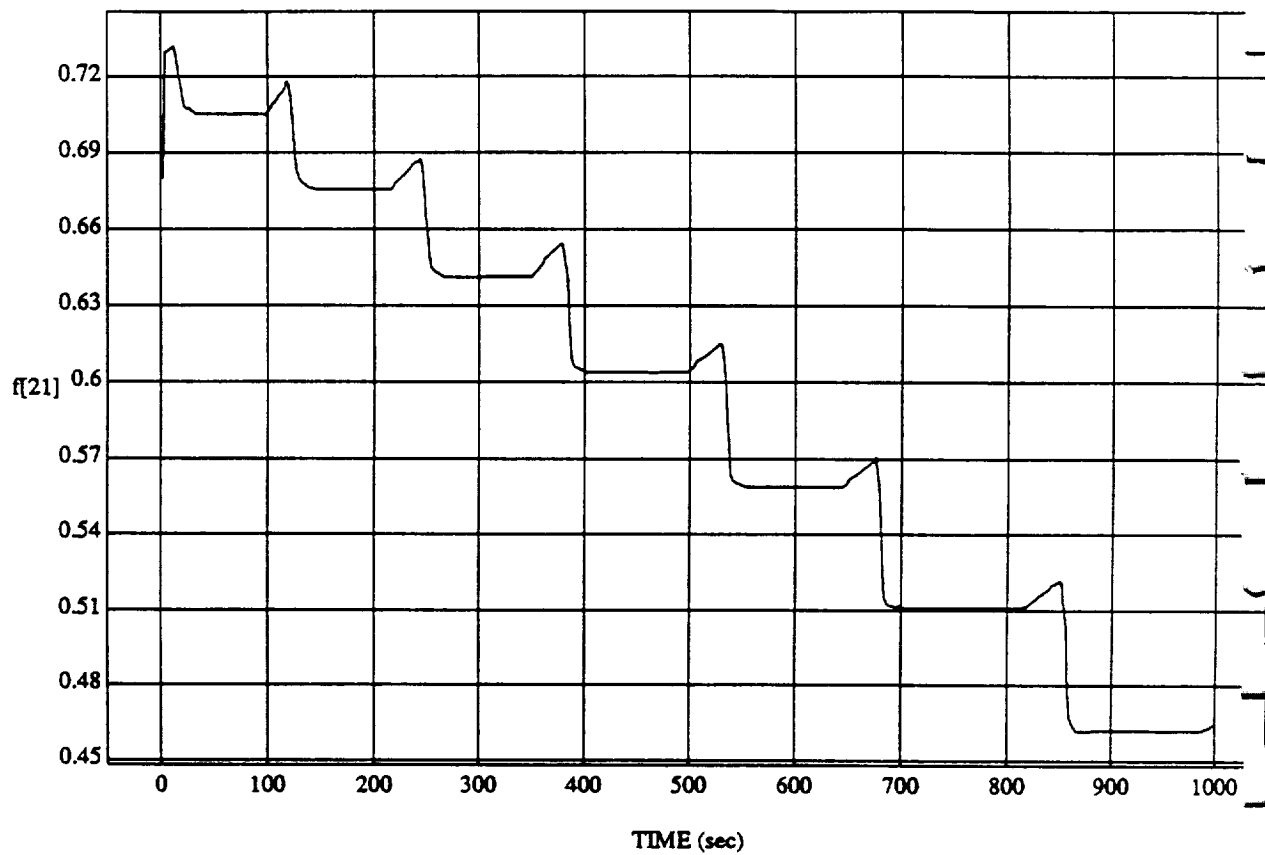


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[21] vs TIME

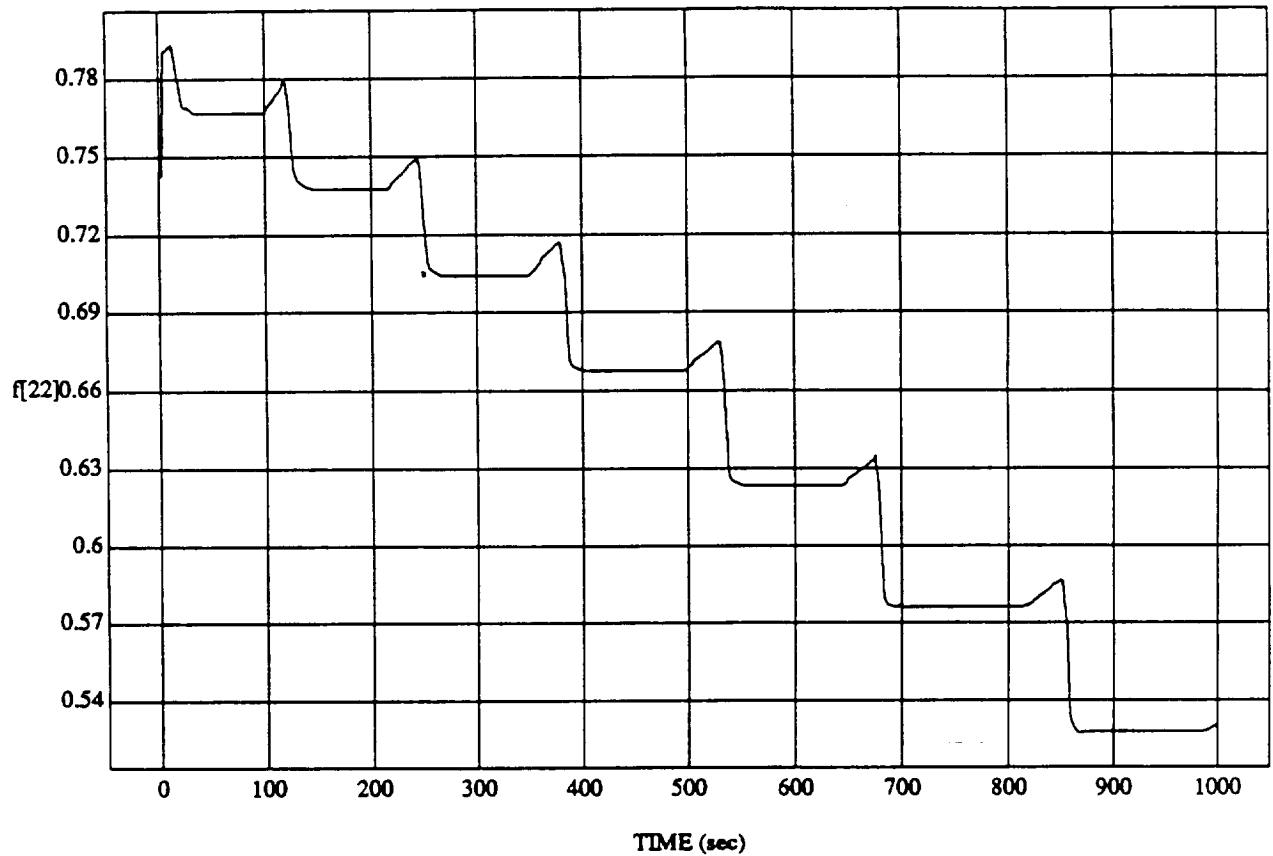
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[22]$  vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

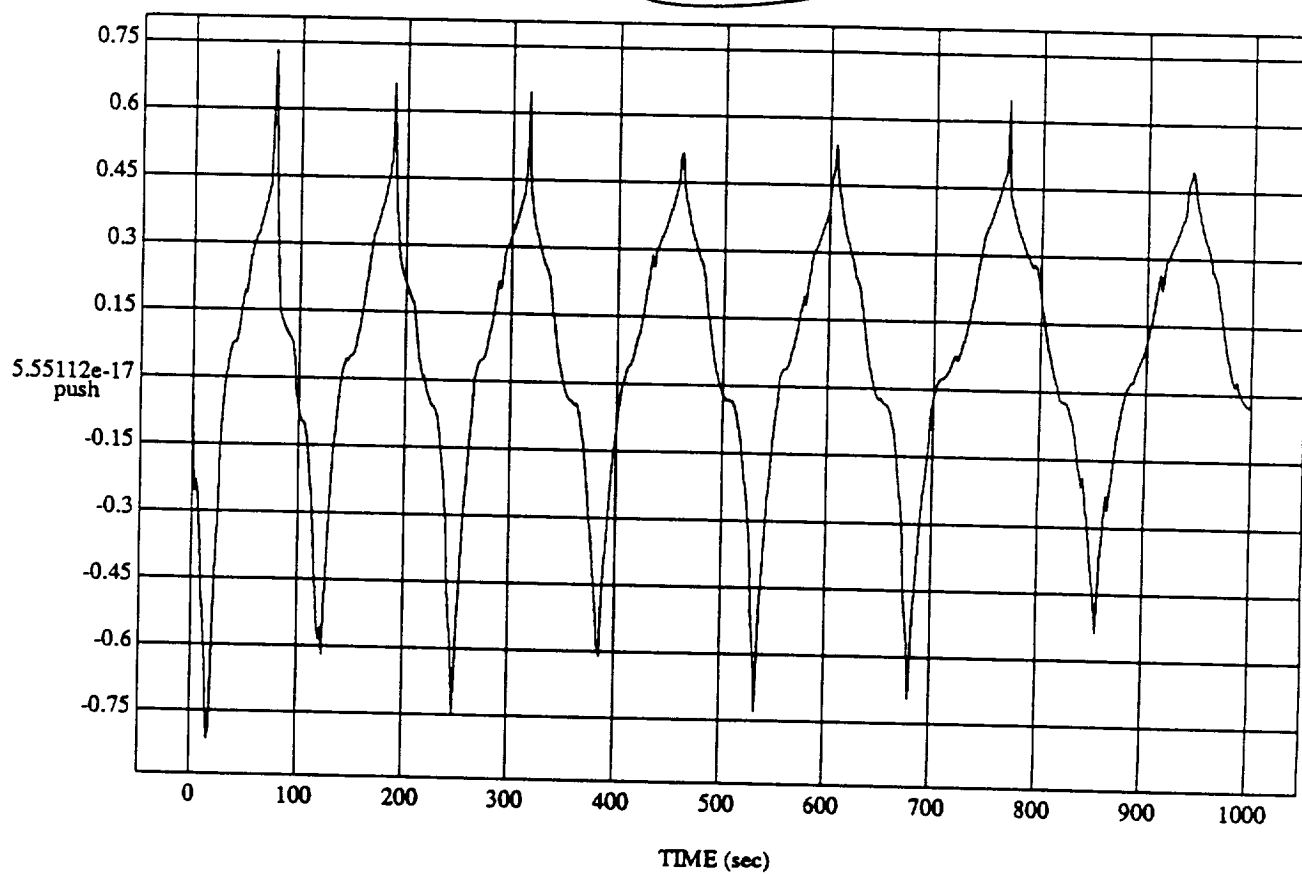




I

# SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

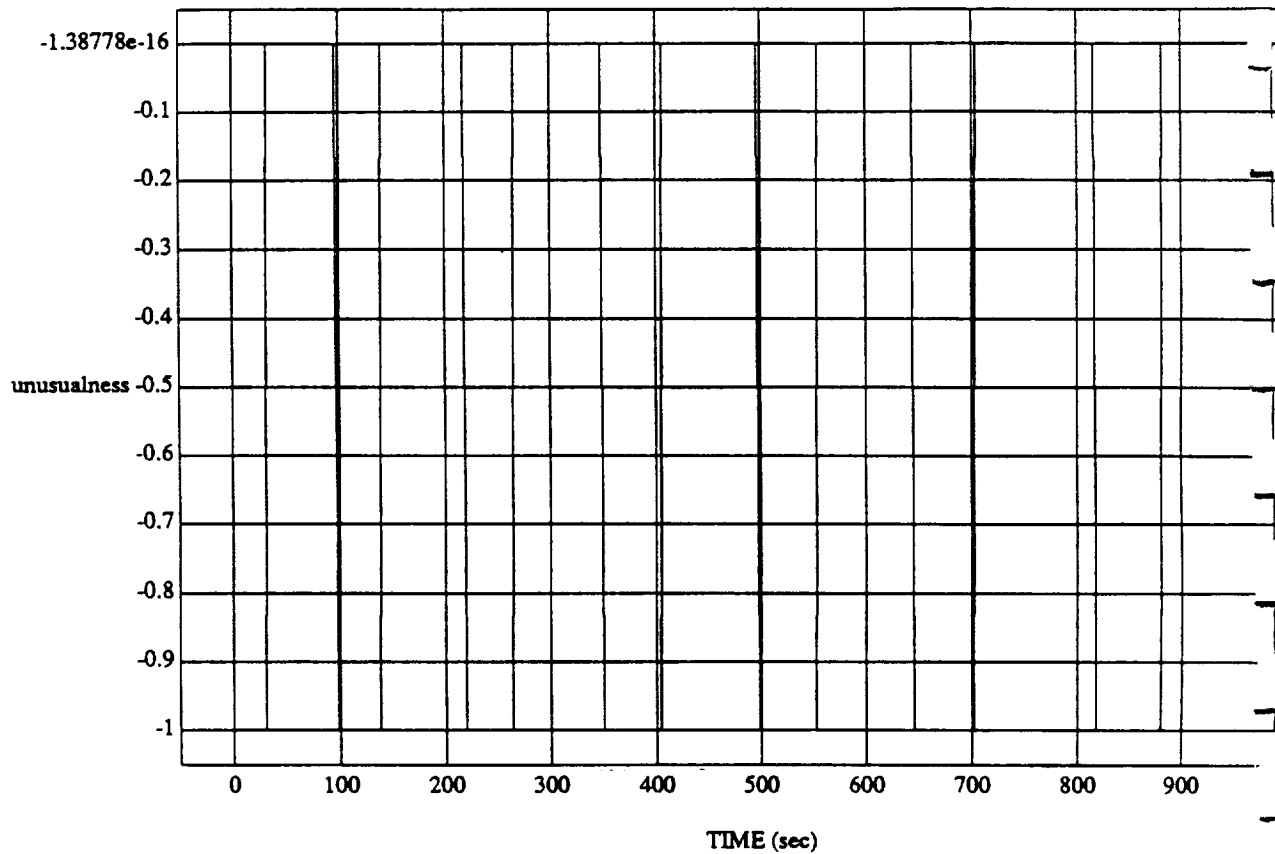
push vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

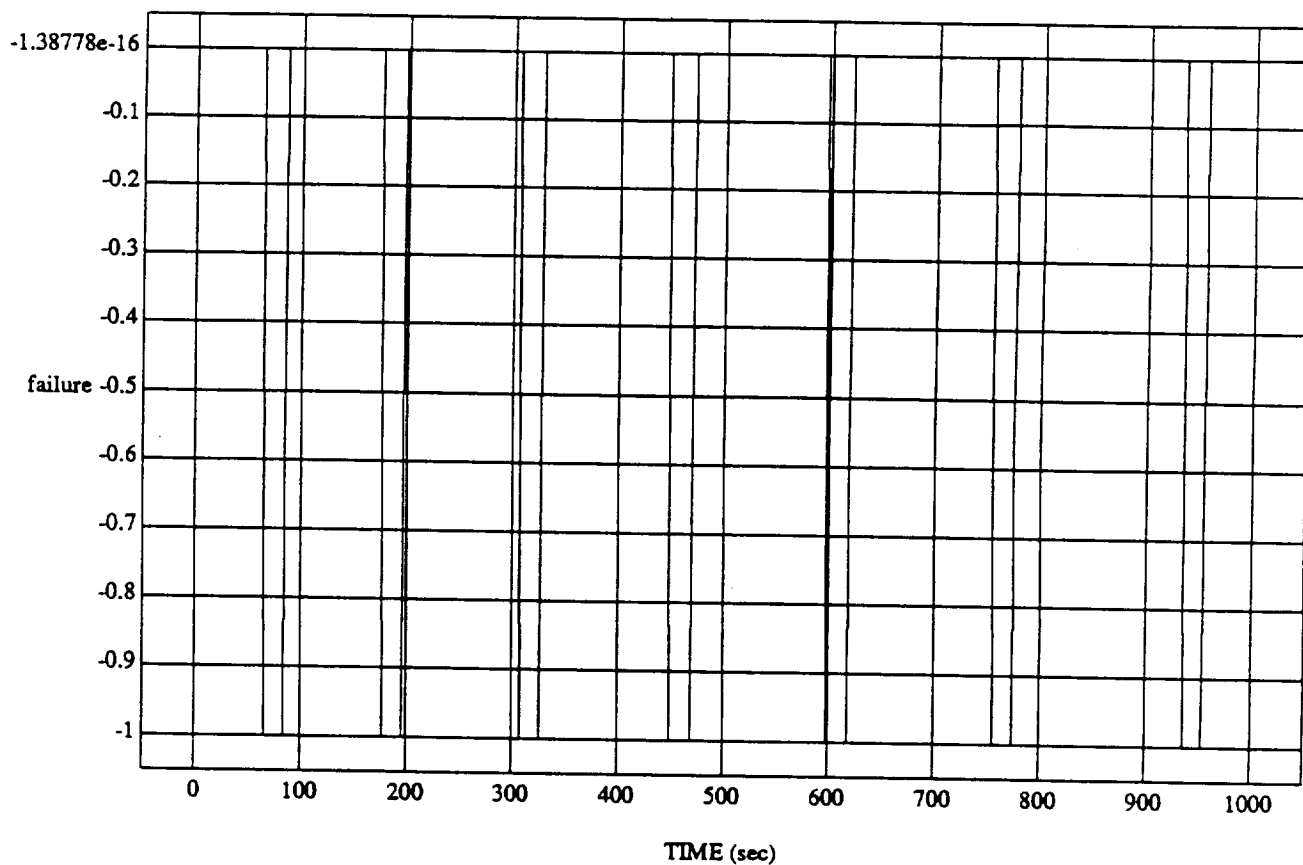
unusualness vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

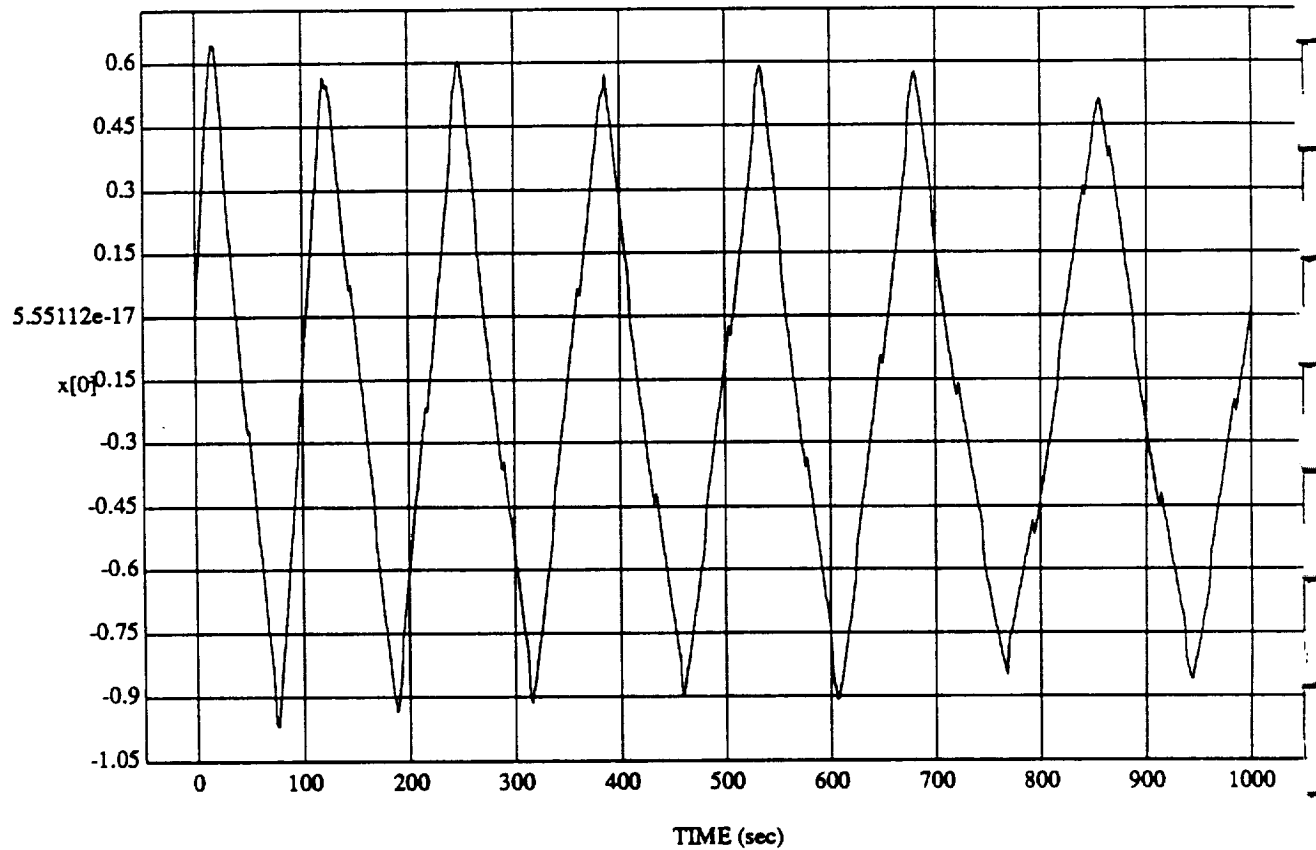
failure vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

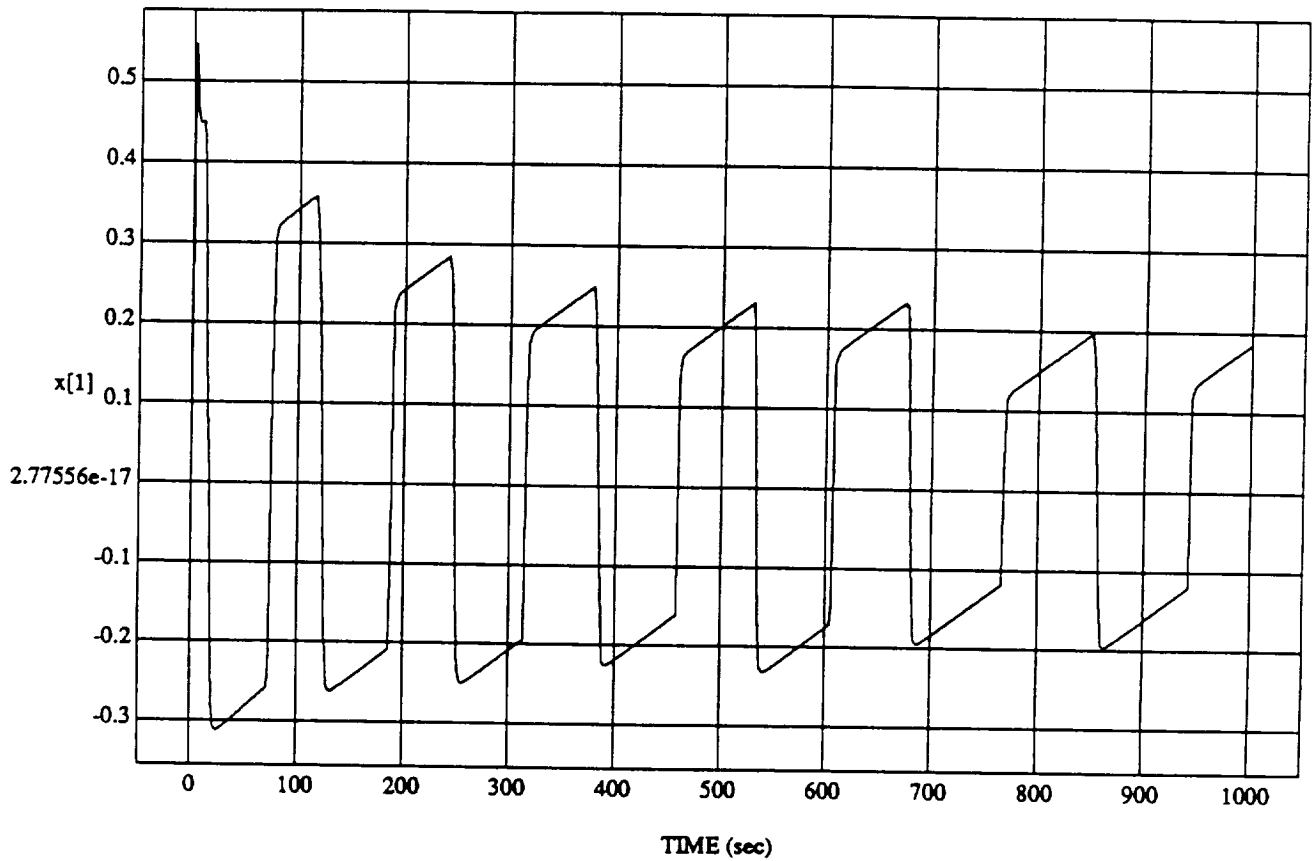
x[0] vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

x[1] vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992

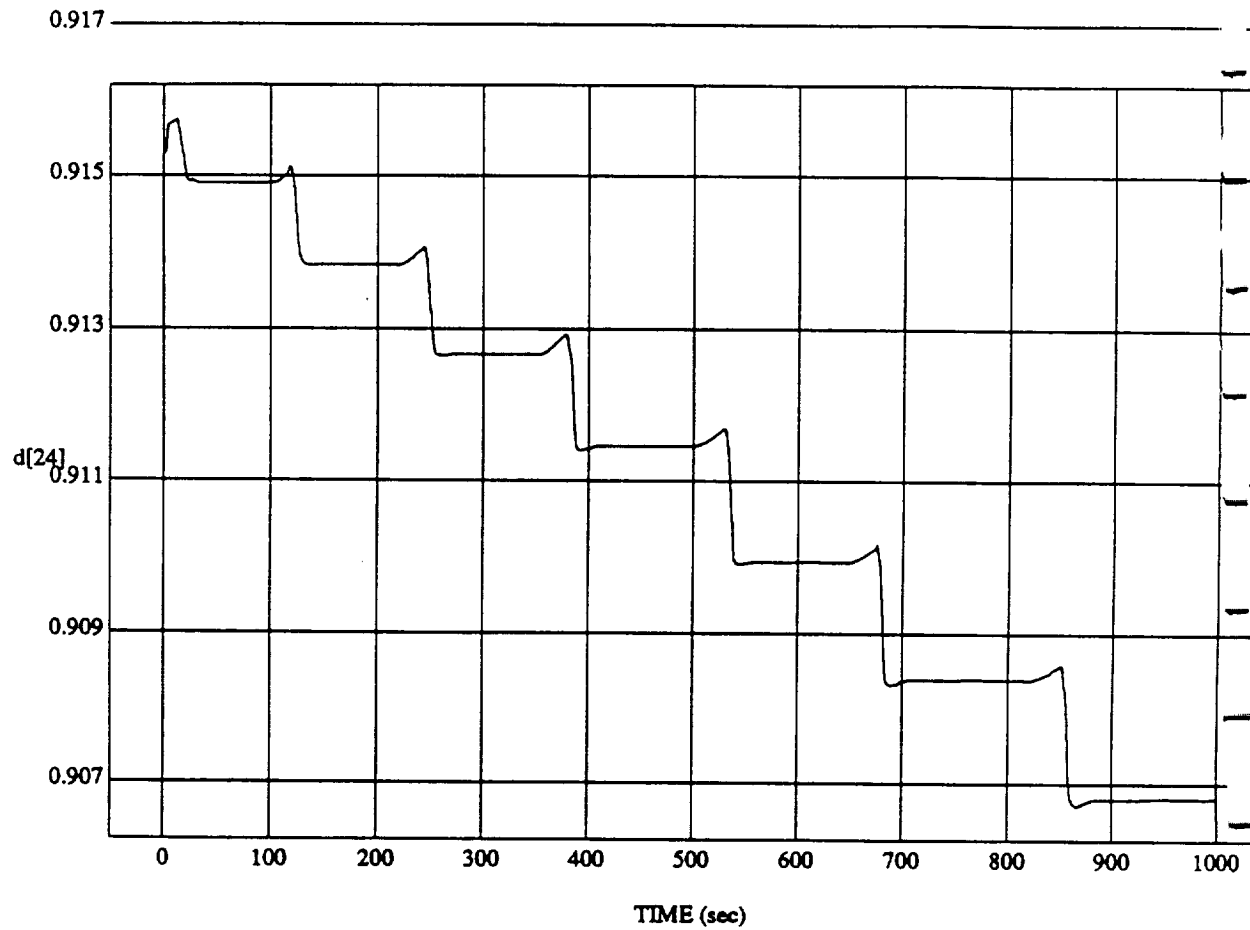


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[24] vs TIME

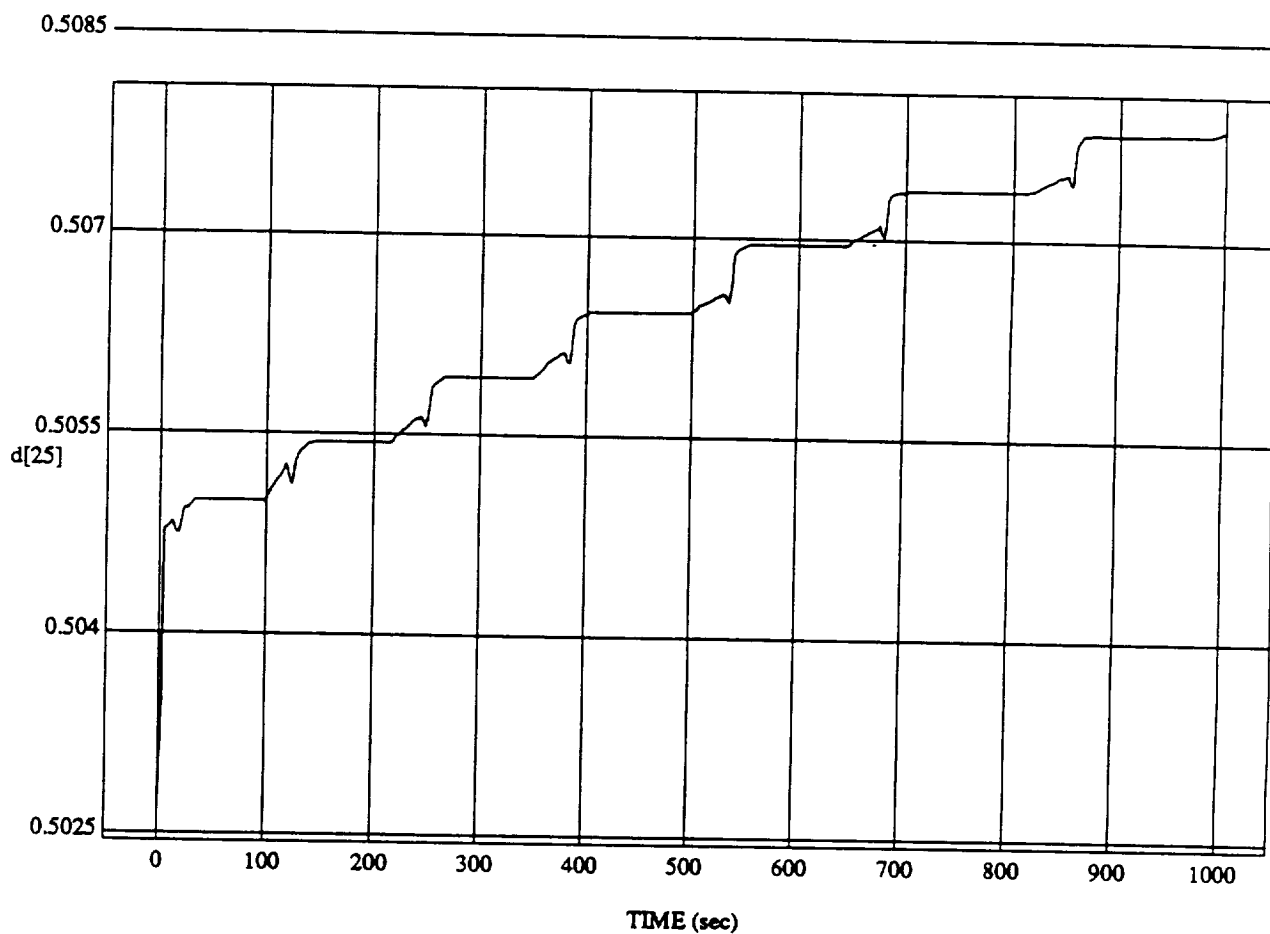
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

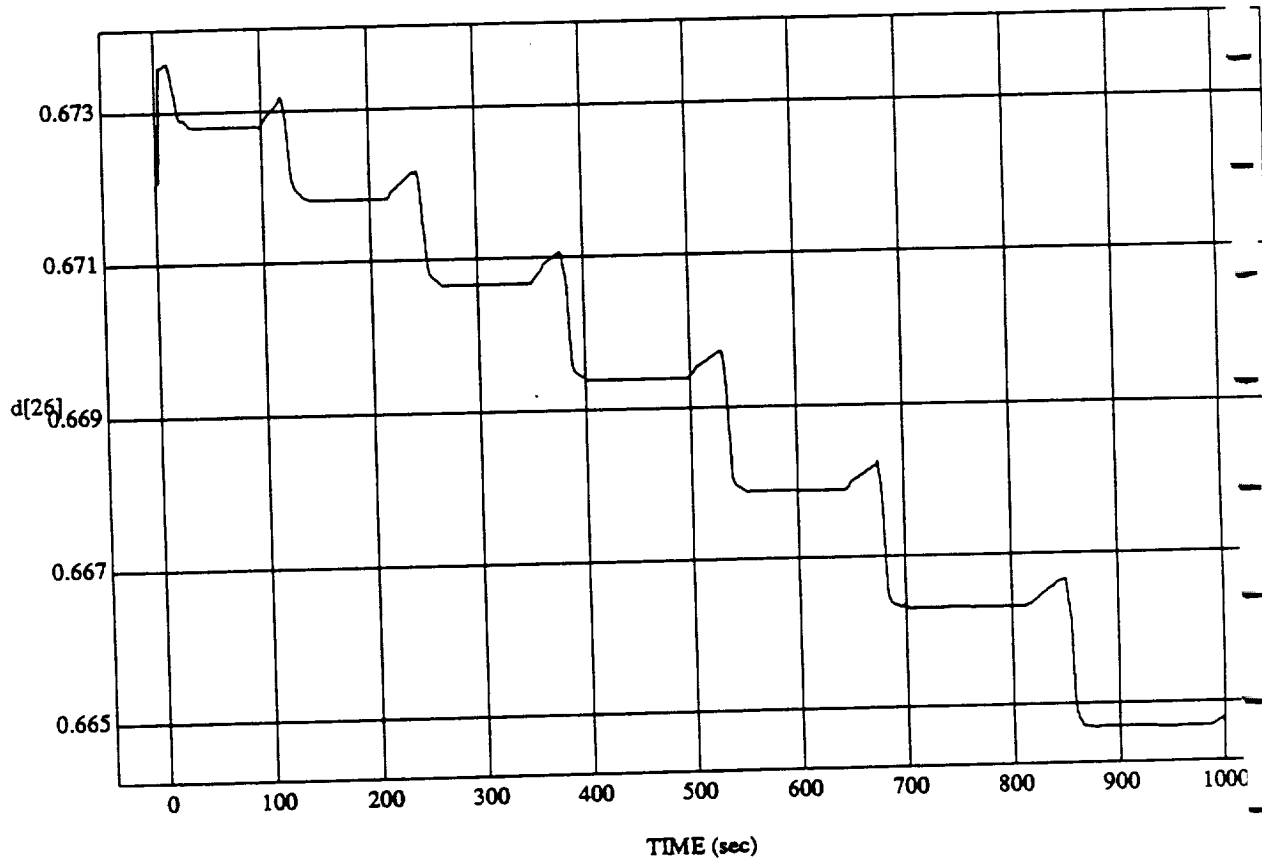
d[25] vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[26] vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992

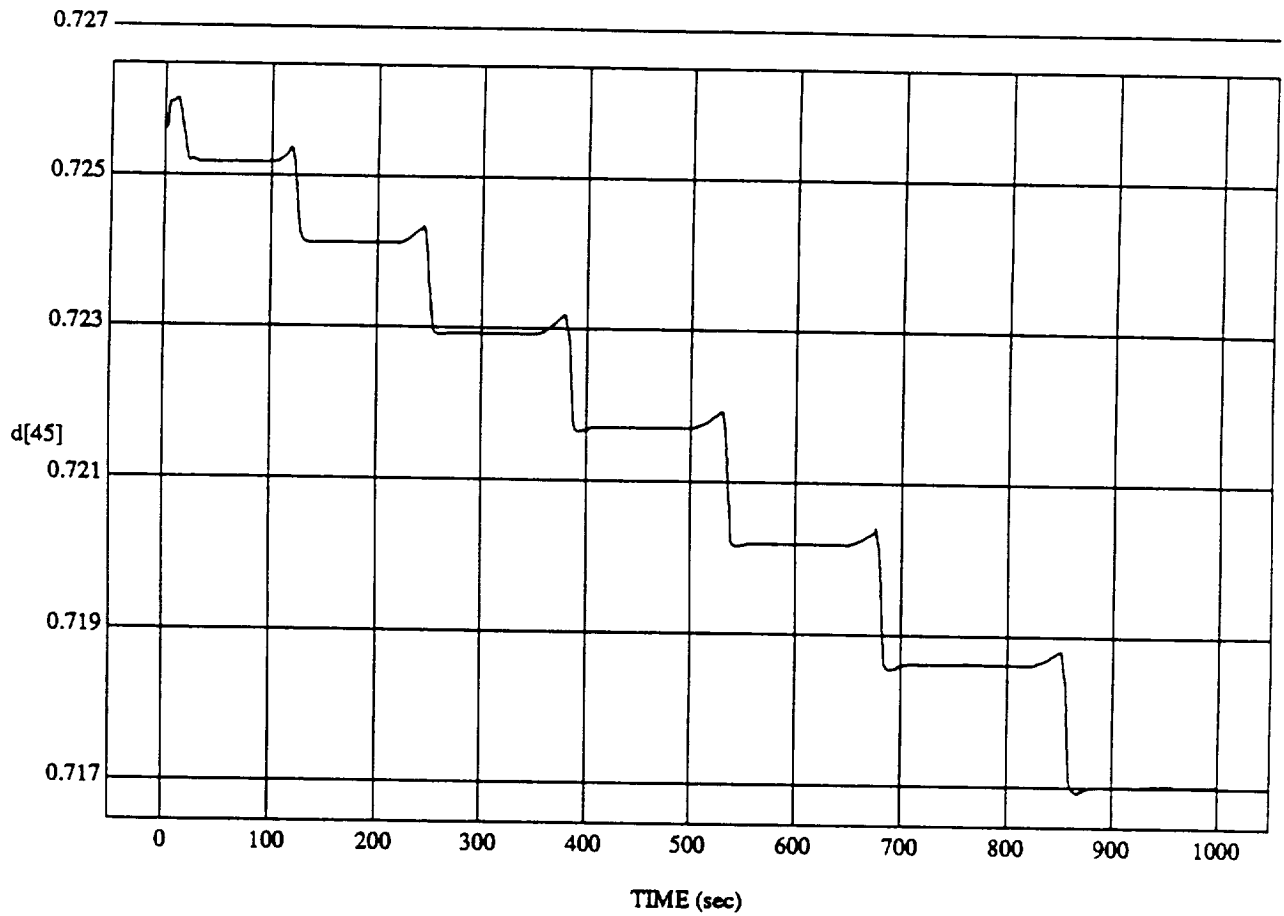


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

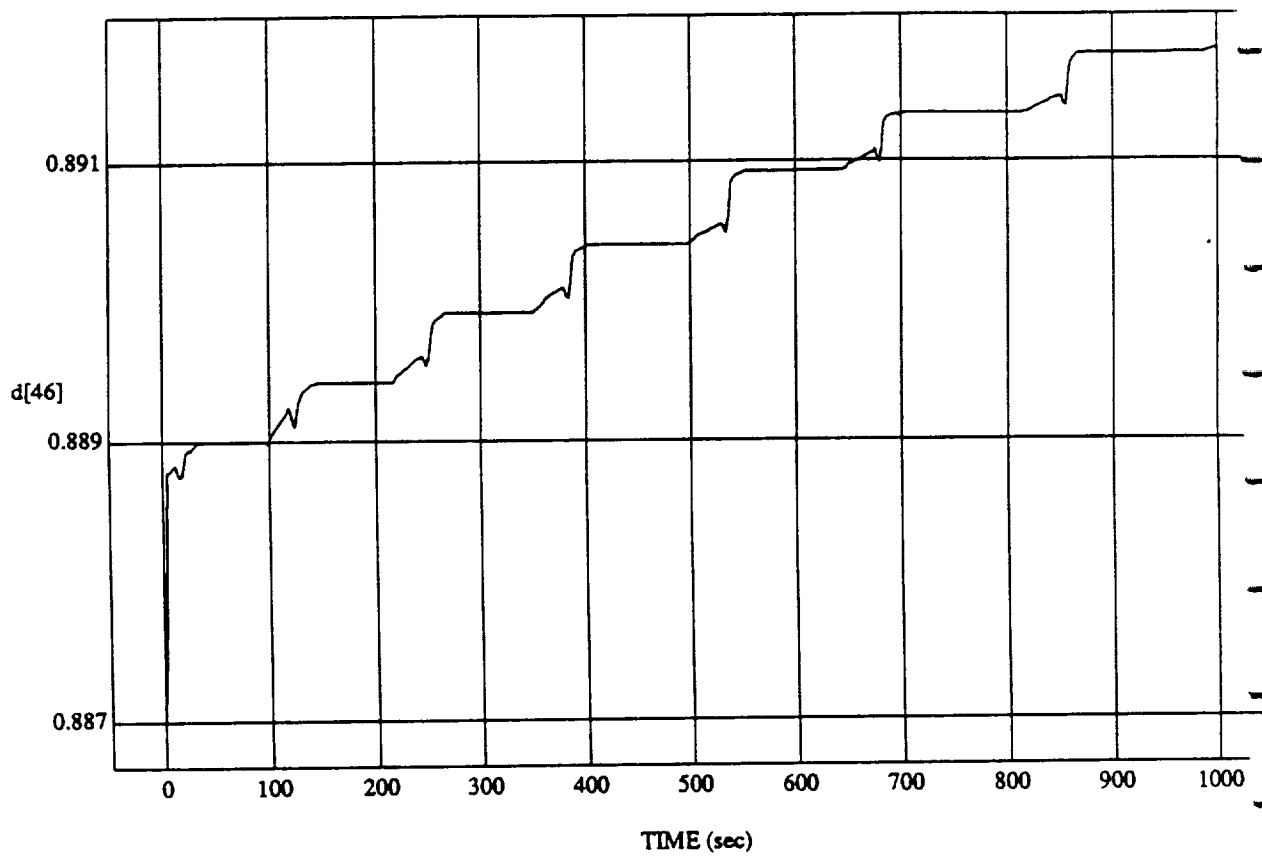
d[45] vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

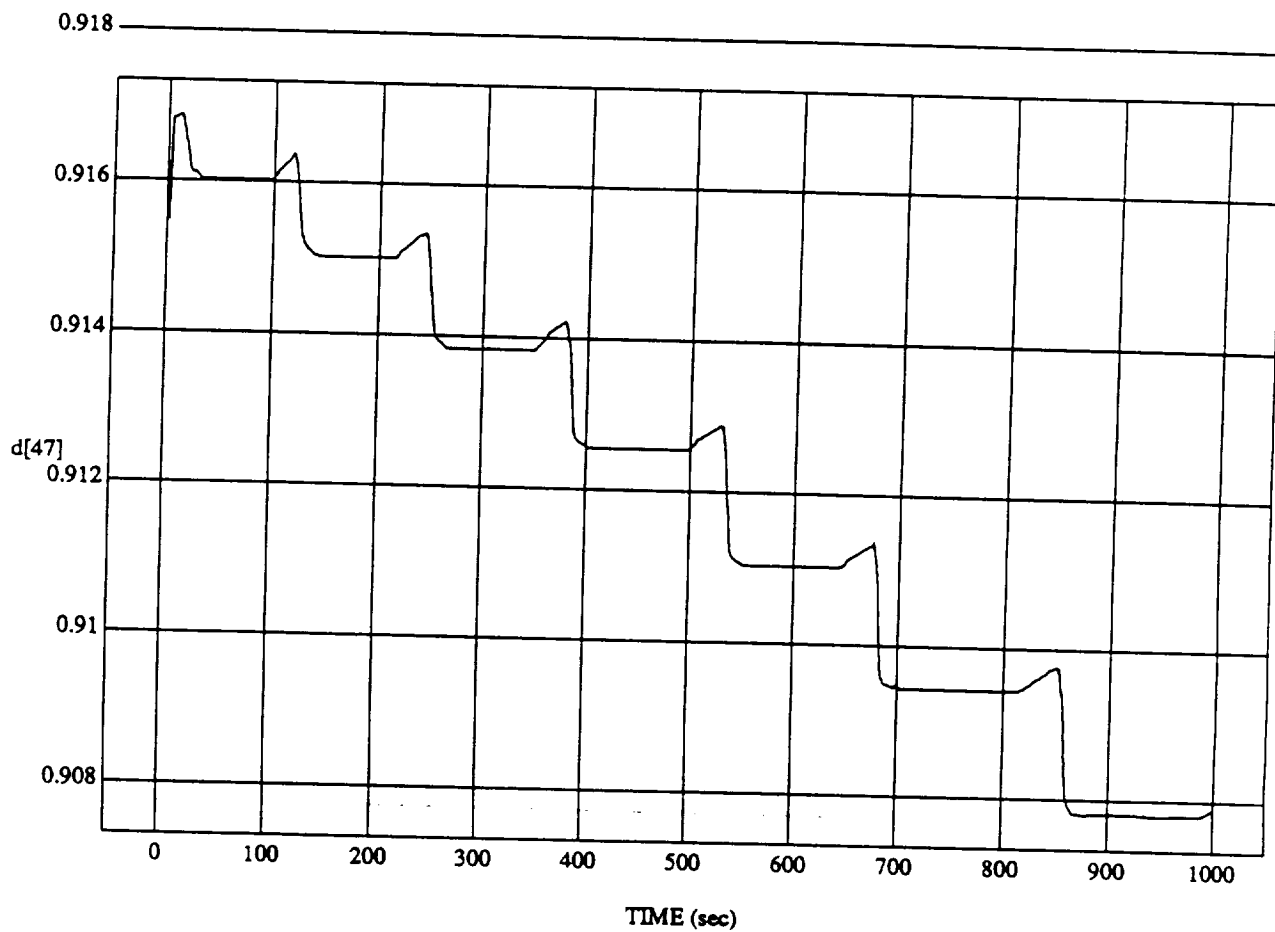
d[46] vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

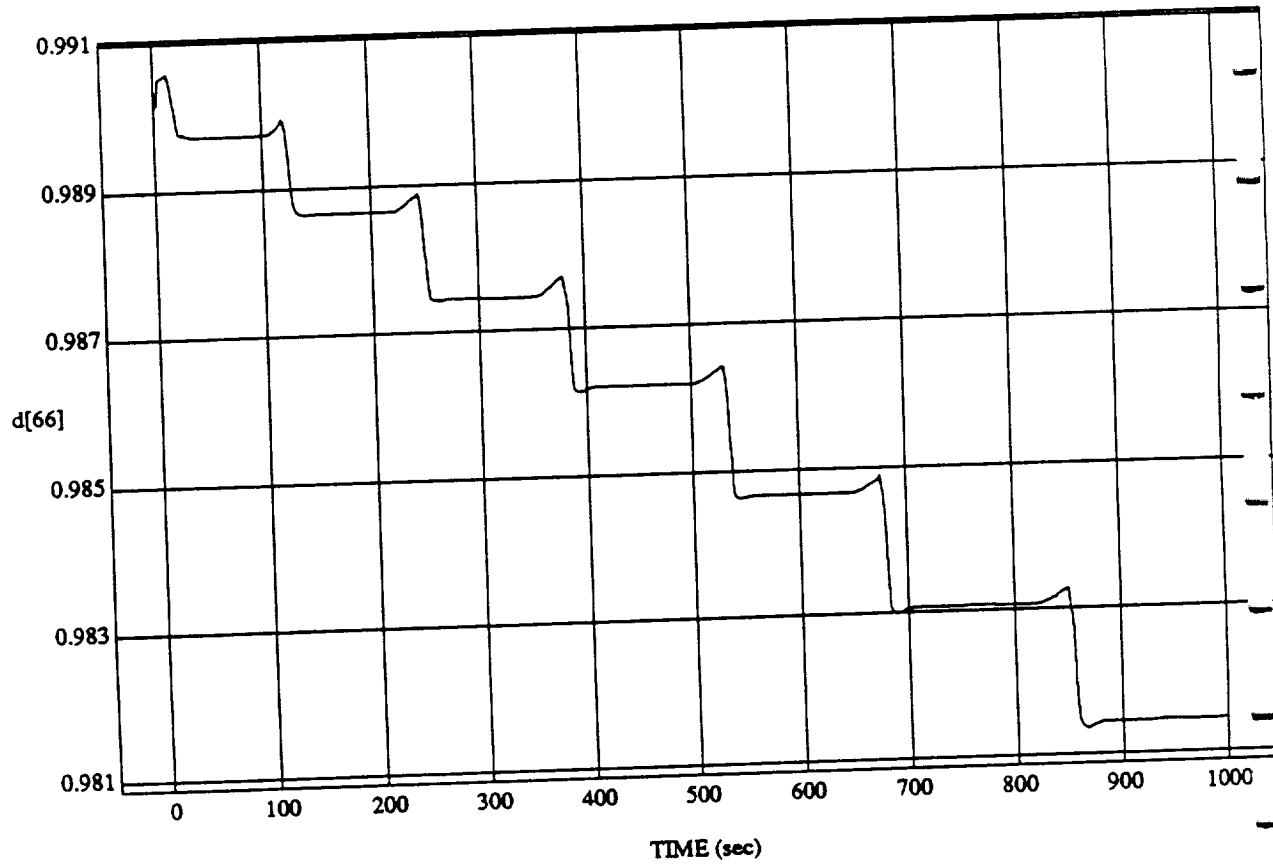
d[47] vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[66] vs TIME  
RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992

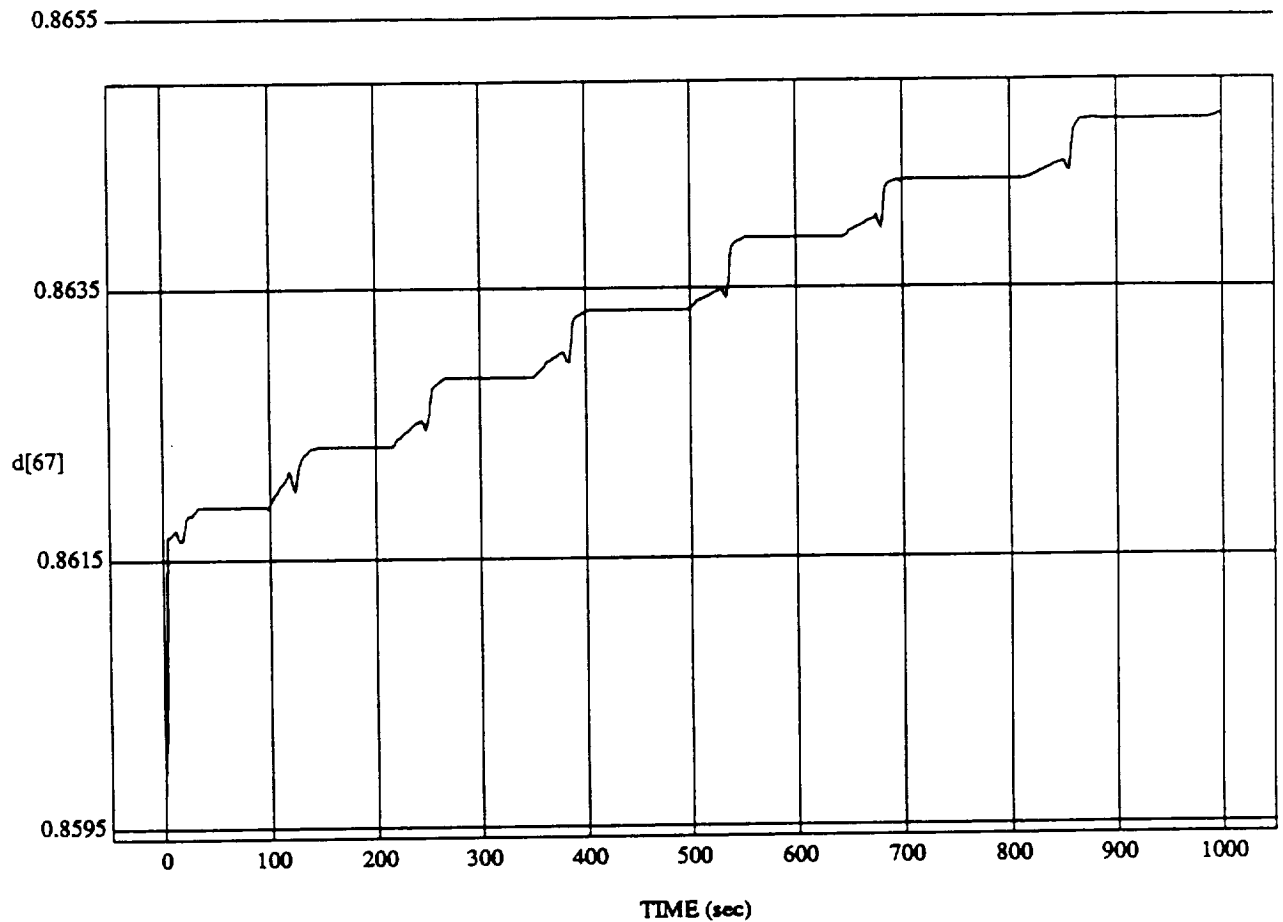


MODULE: ORB\_FUZZ\_BATCH.1cam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[67] vs TIME

RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992

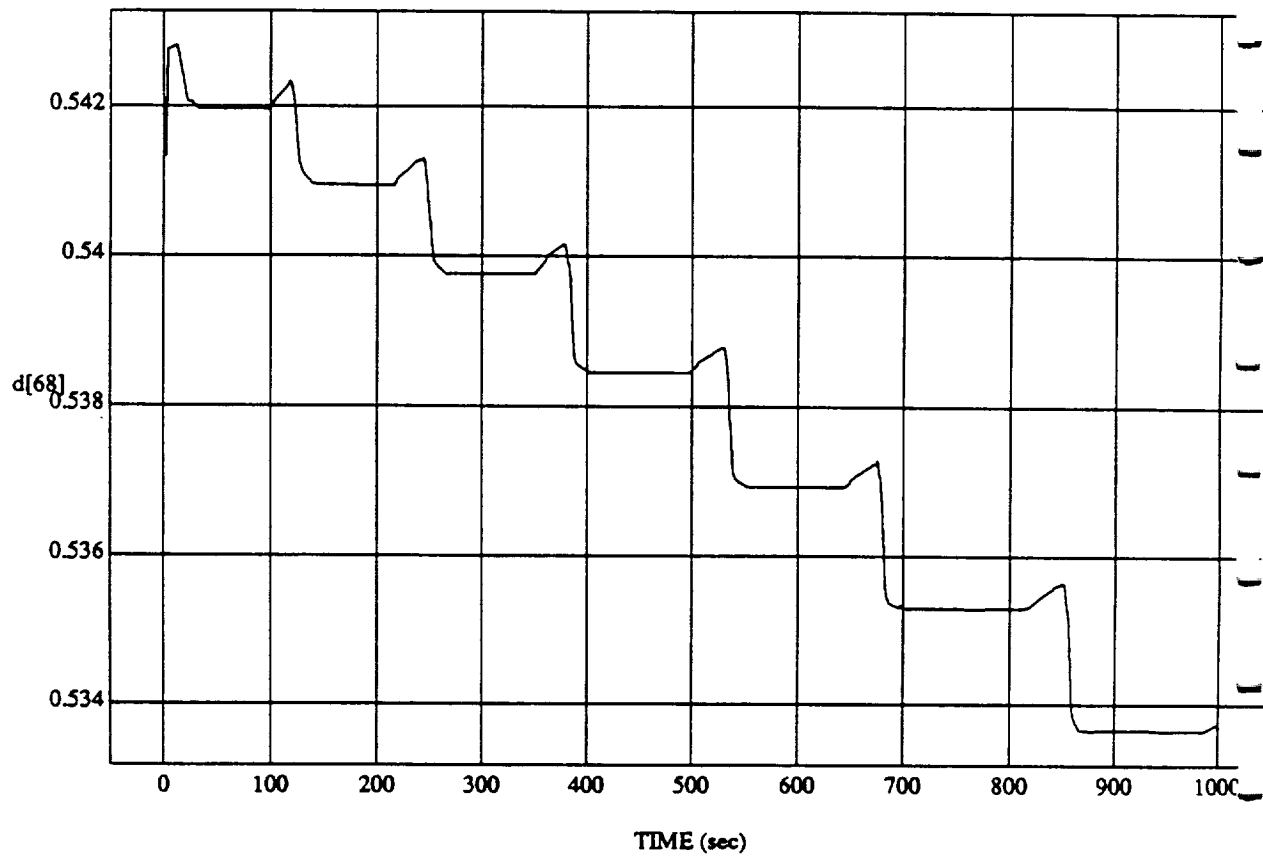


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[68] vs TIME

RUN: Fuzzy / NN Learner - Randomized D's - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

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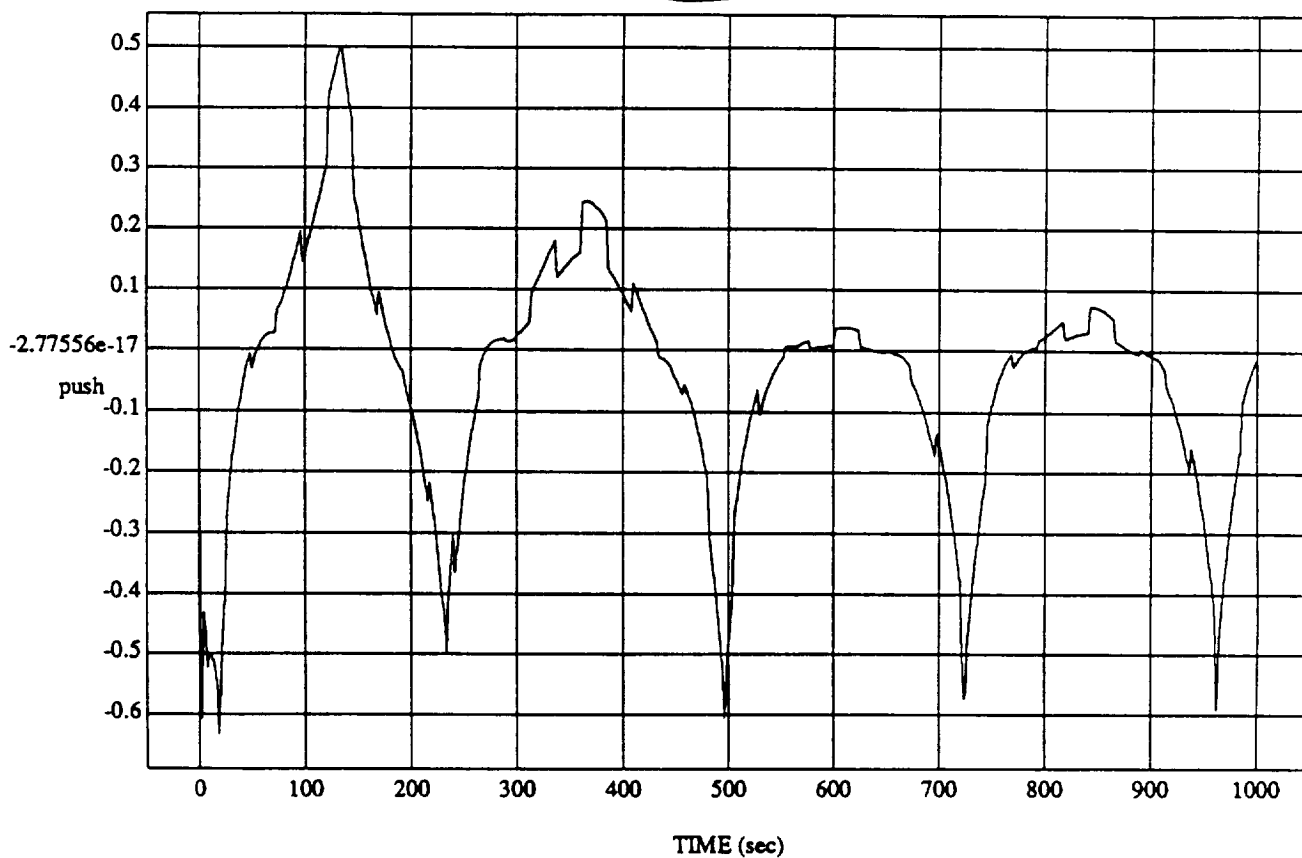
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II

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

push vs TIME  
RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



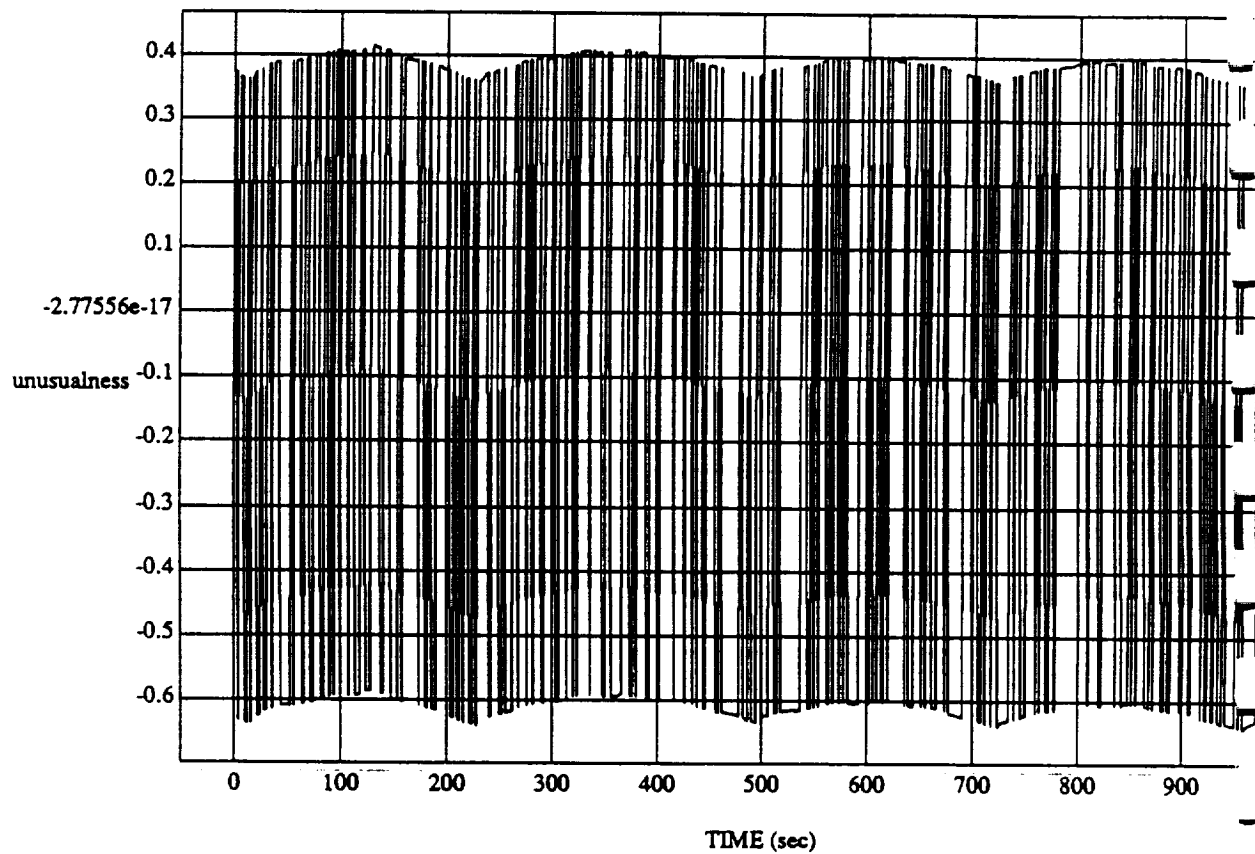
MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

ORBITAL OPERATIONS SIMULATOR

Mon May 04 1992 11:30:27 AM

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

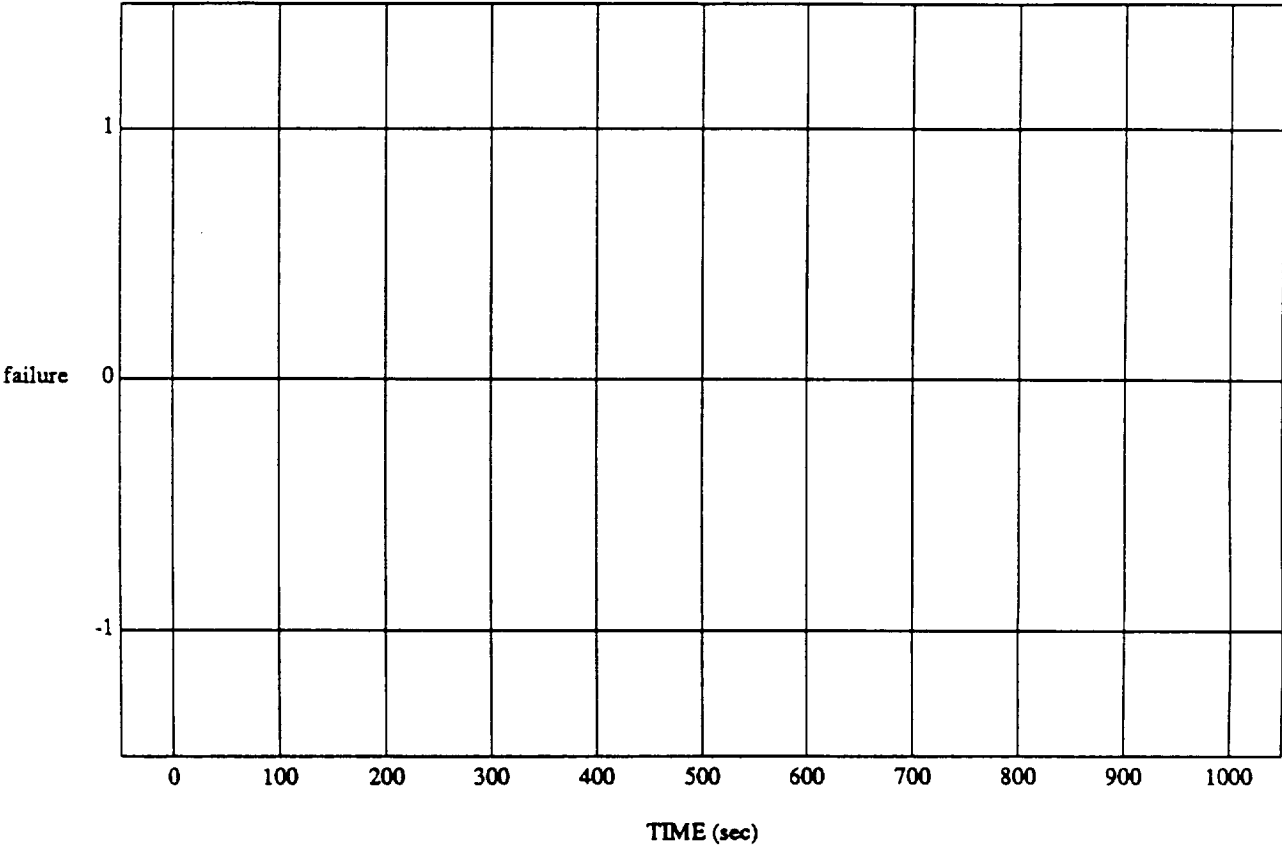
unusualness vs TIME  
RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

failure vs TIME  
RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992

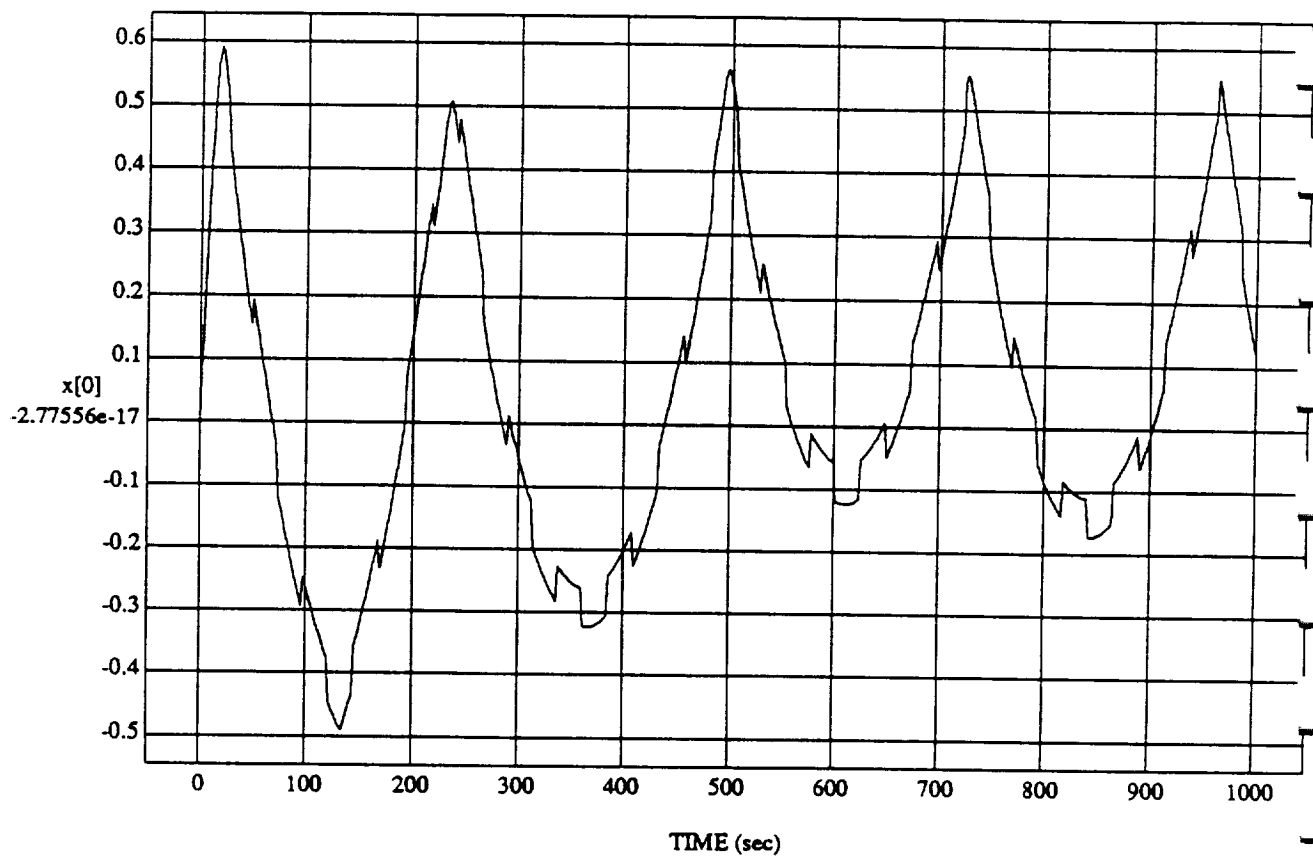


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$x[0]$  vs TIME

RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



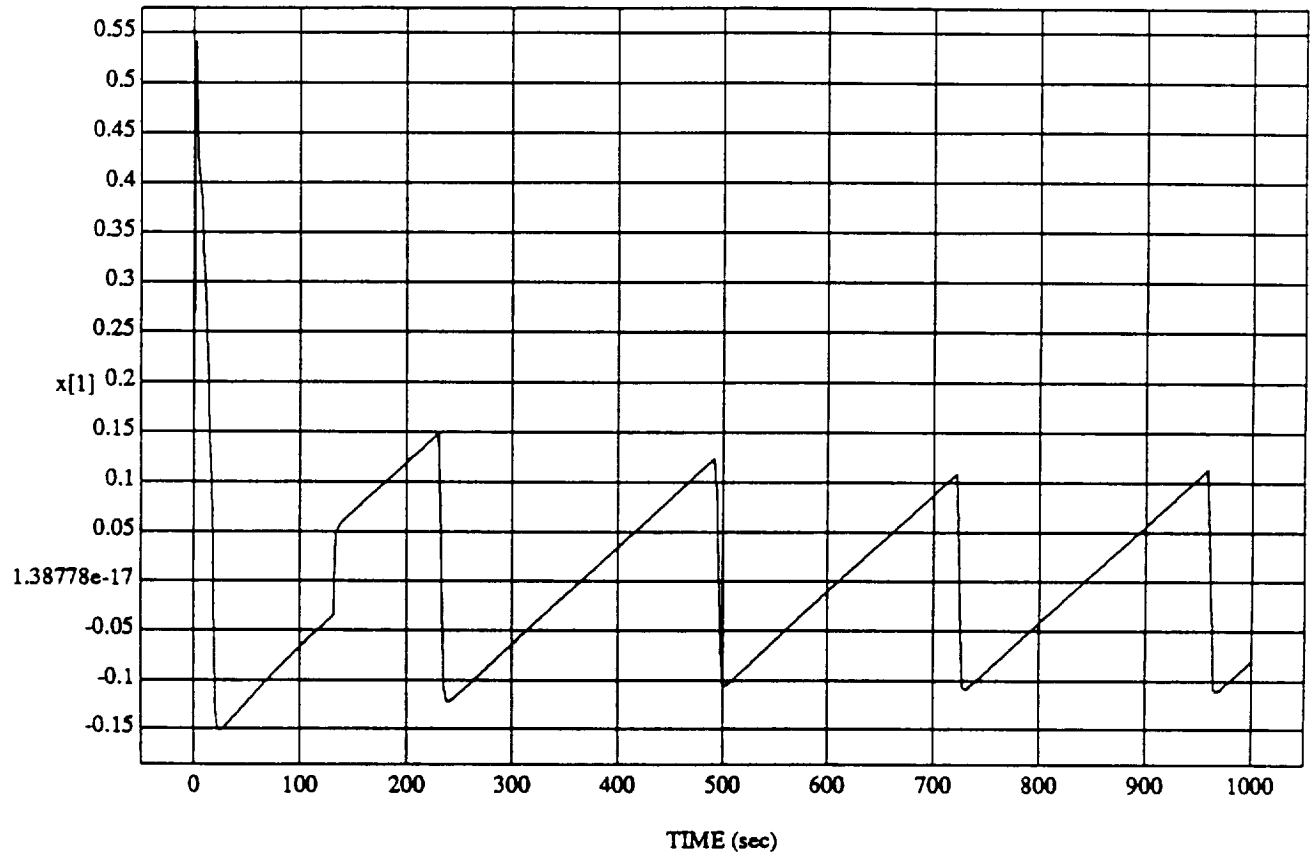
MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

ORBITAL OPERATIONS SIMULATOR

Mon May 04 1992 11:30:27 AM

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

x[1] vs TIME  
RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992

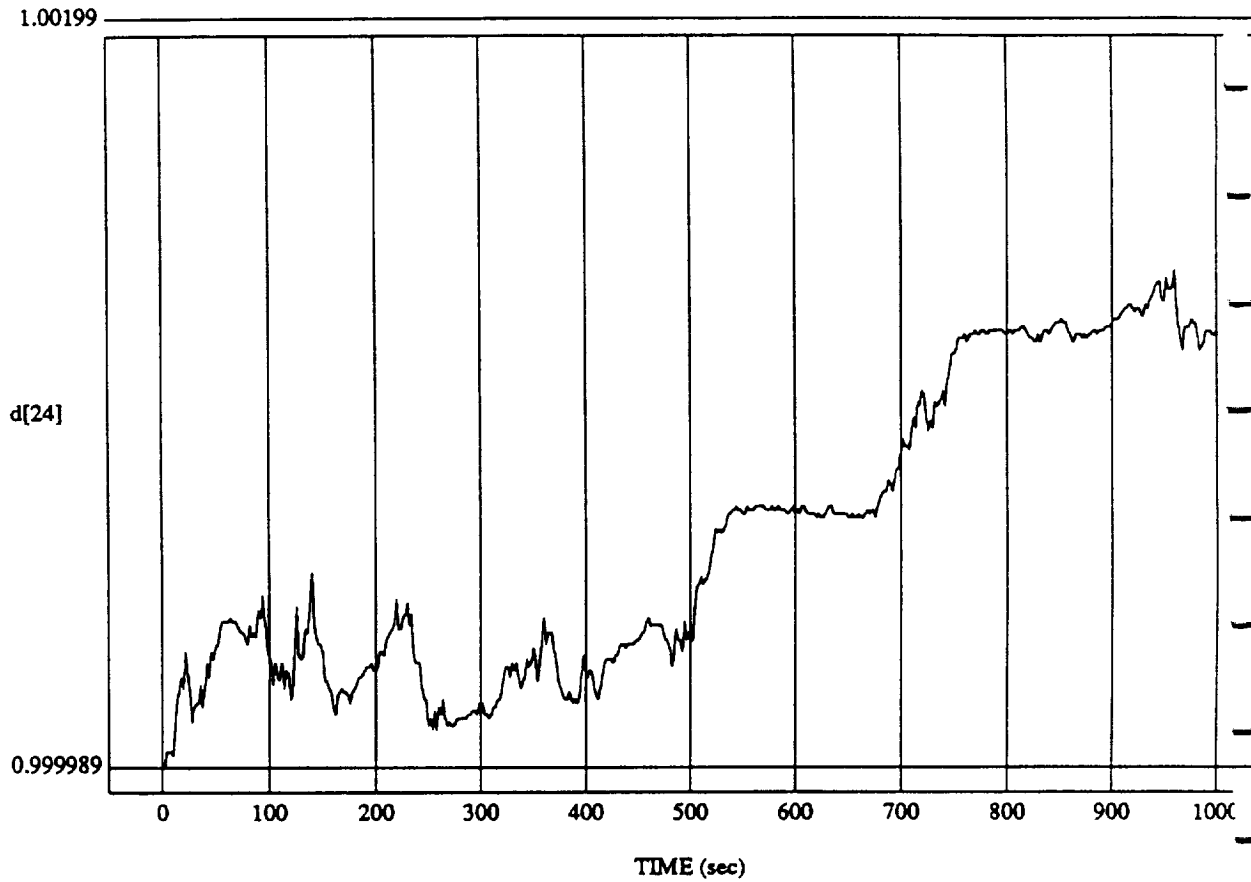


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[24] vs TIME

RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

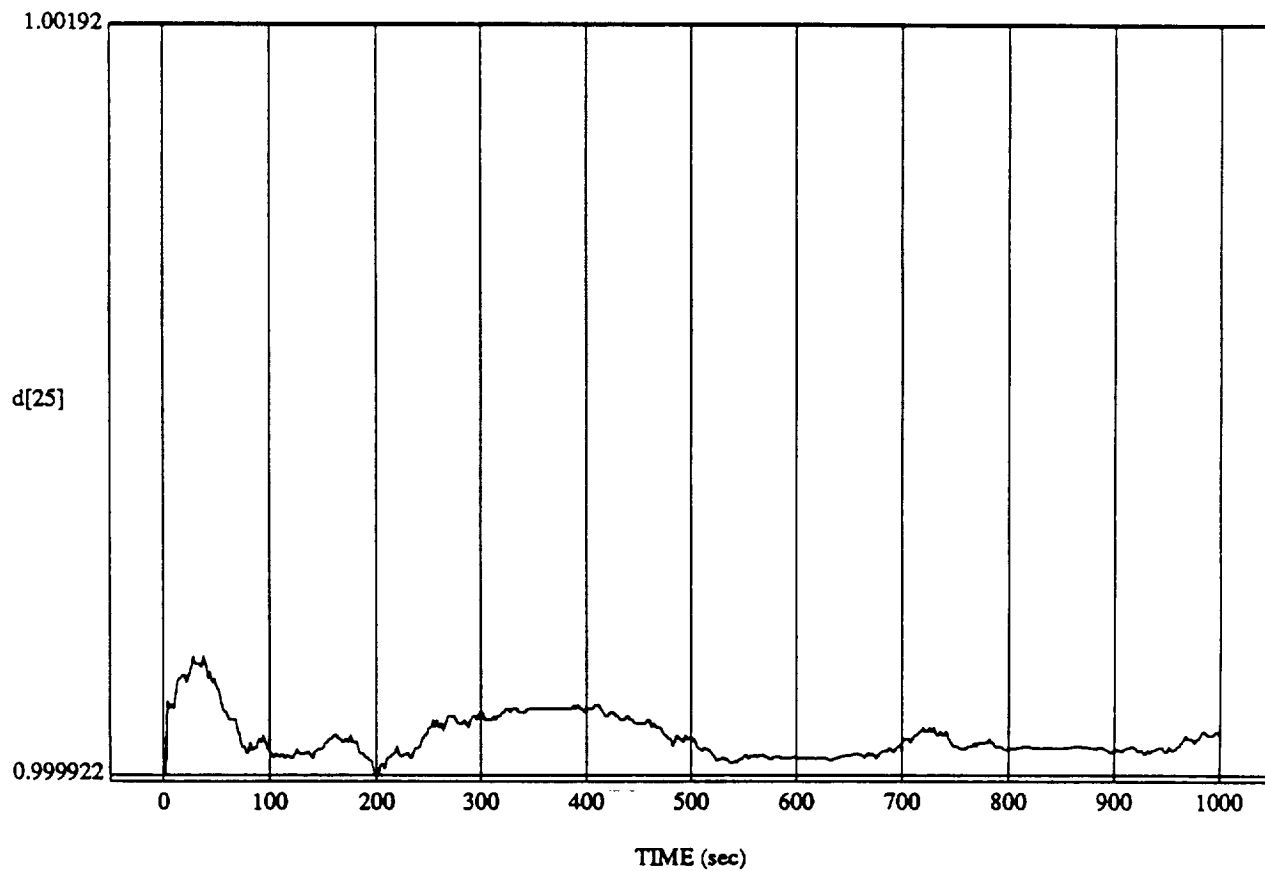
ORBITAL OPERATIONS SIMULATOR

Mon May 04 1992 11:30:27 A

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[25] vs TIME

RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

ORBITAL OPERATIONS SIMULATOR

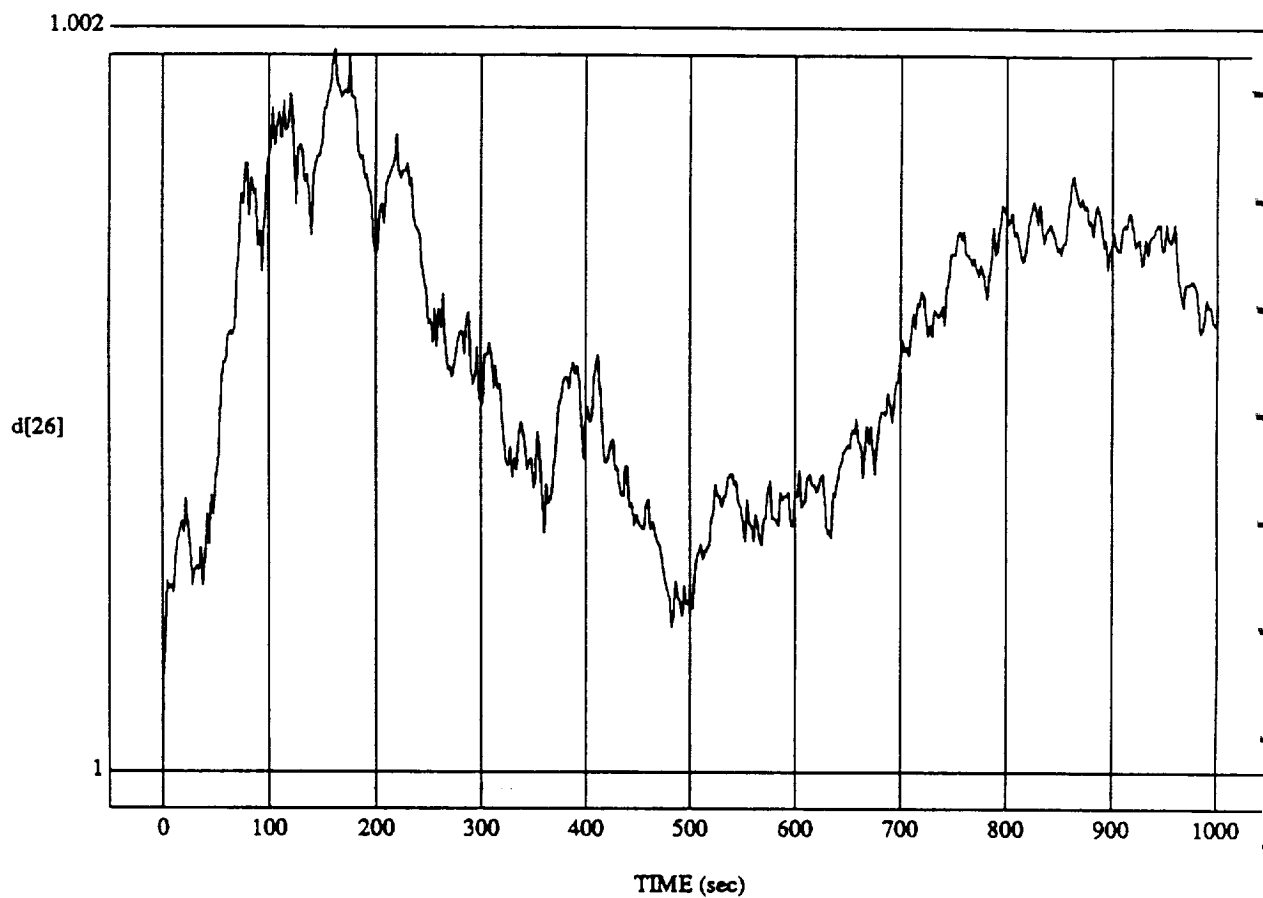
7

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SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[26] vs TIME

RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

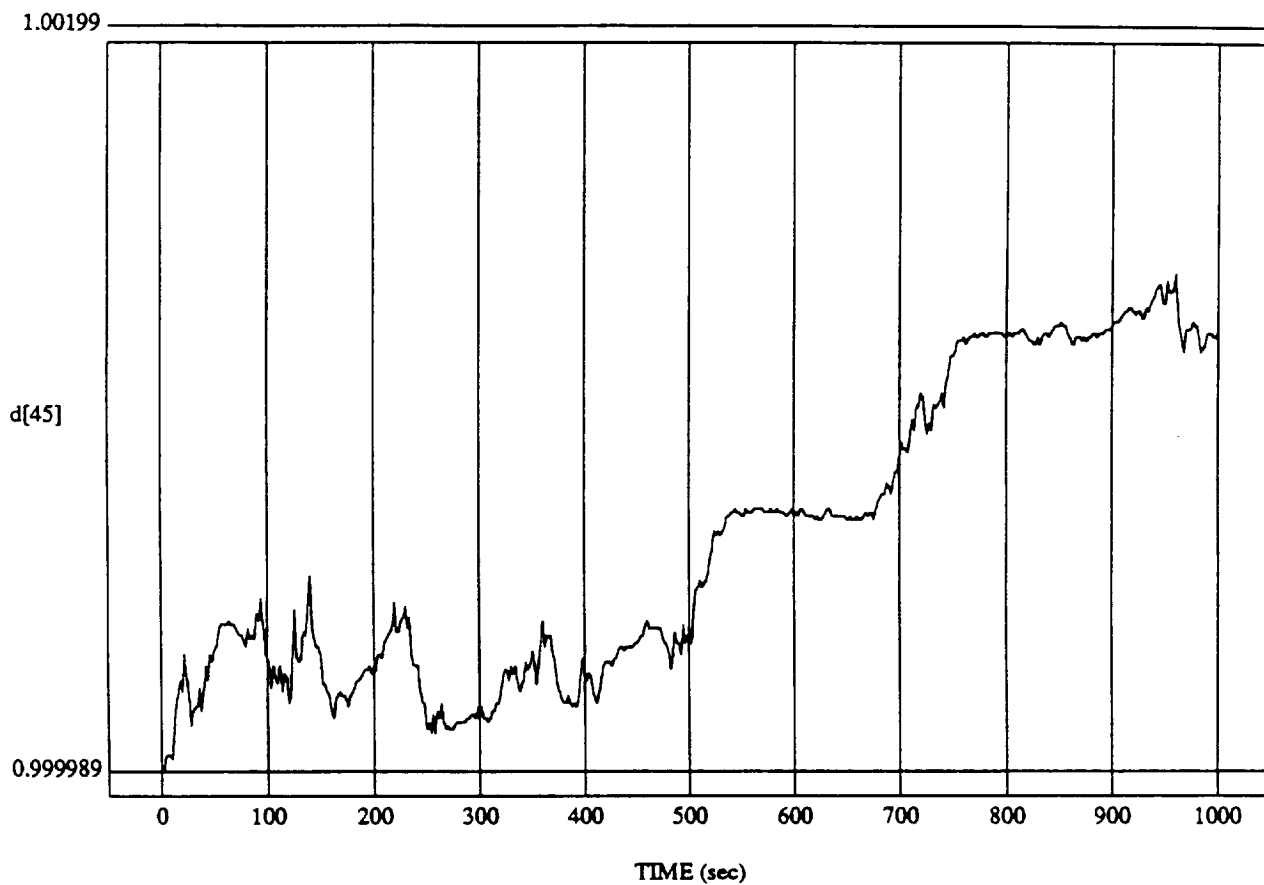
ORBITAL OPERATIONS SIMULATOR

Mon May 04 1992 11:30:27 AM



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[45] vs TIME  
RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

ORBITAL OPERATIONS SIMULATOR

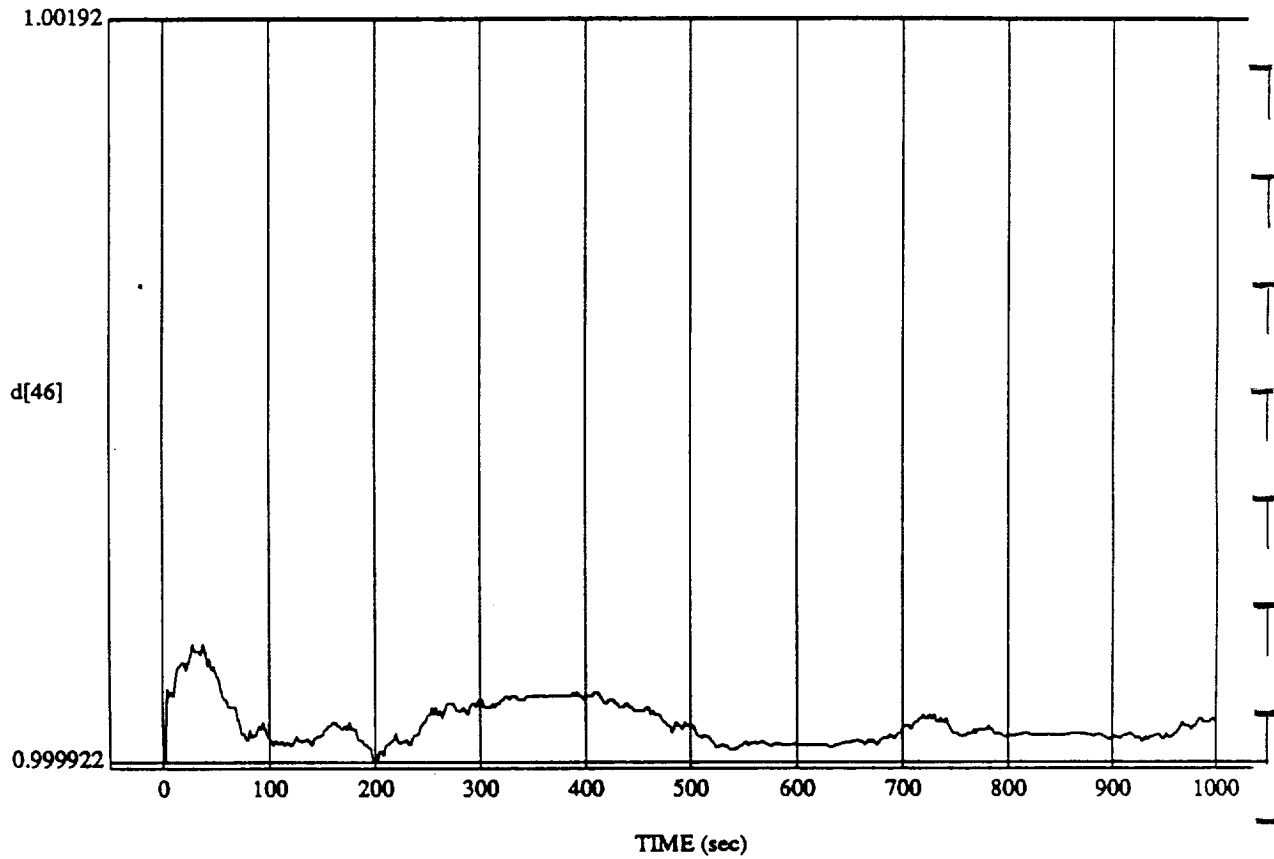
9

Mon May 04 1992 11:30:27 AM

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[46] vs TIME

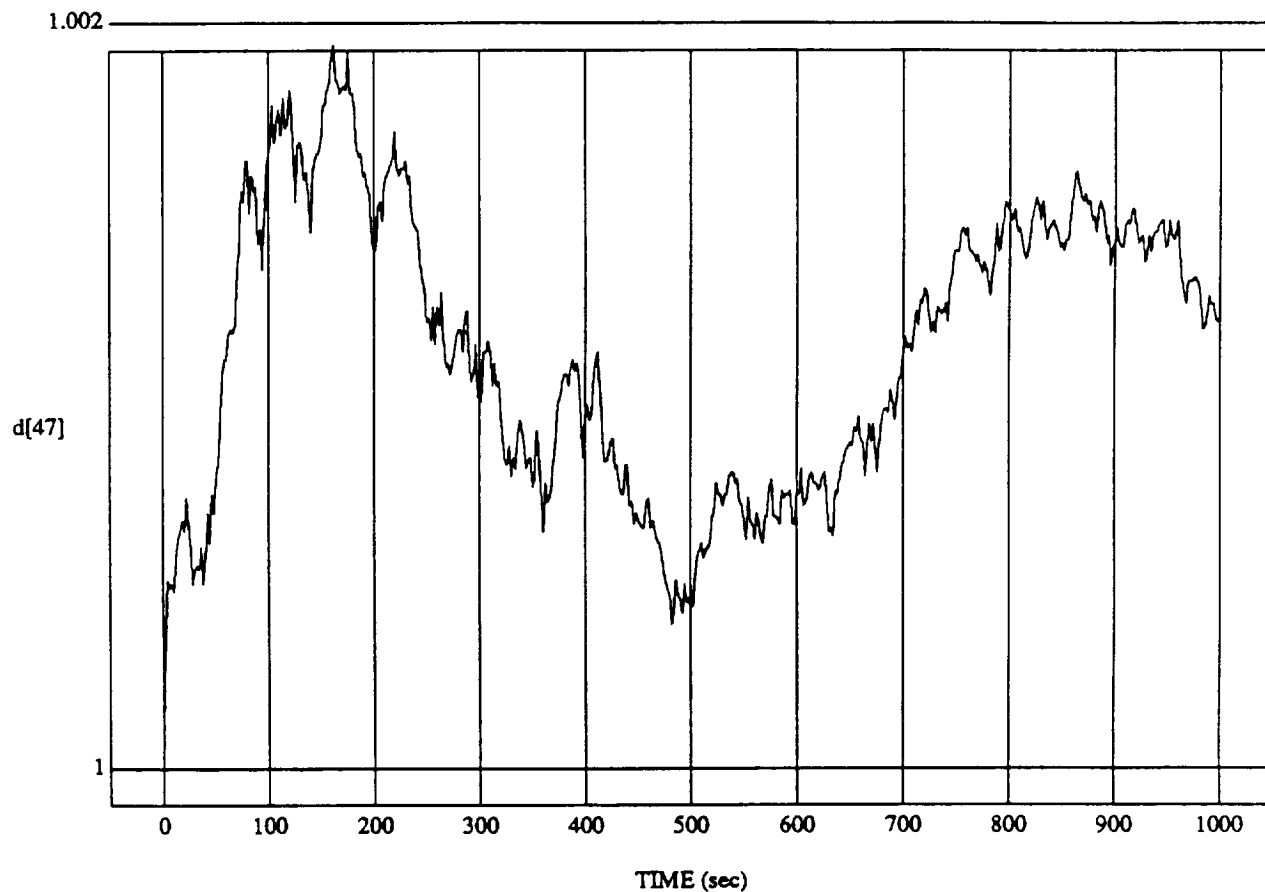
RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[47] vs TIME  
RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

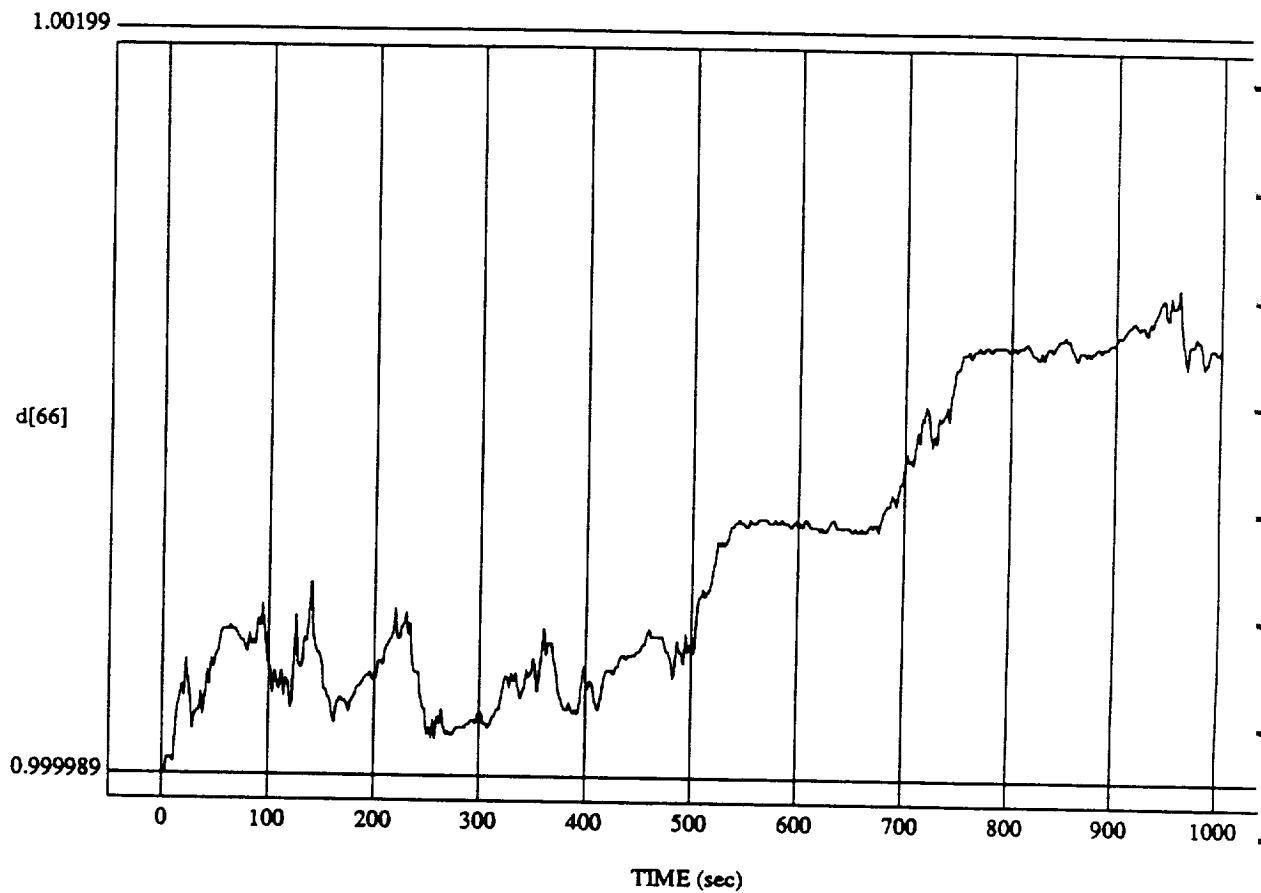
ORBITAL OPERATIONS SIMULATOR

11

Mon May 04 1992 11:30:27 AM

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

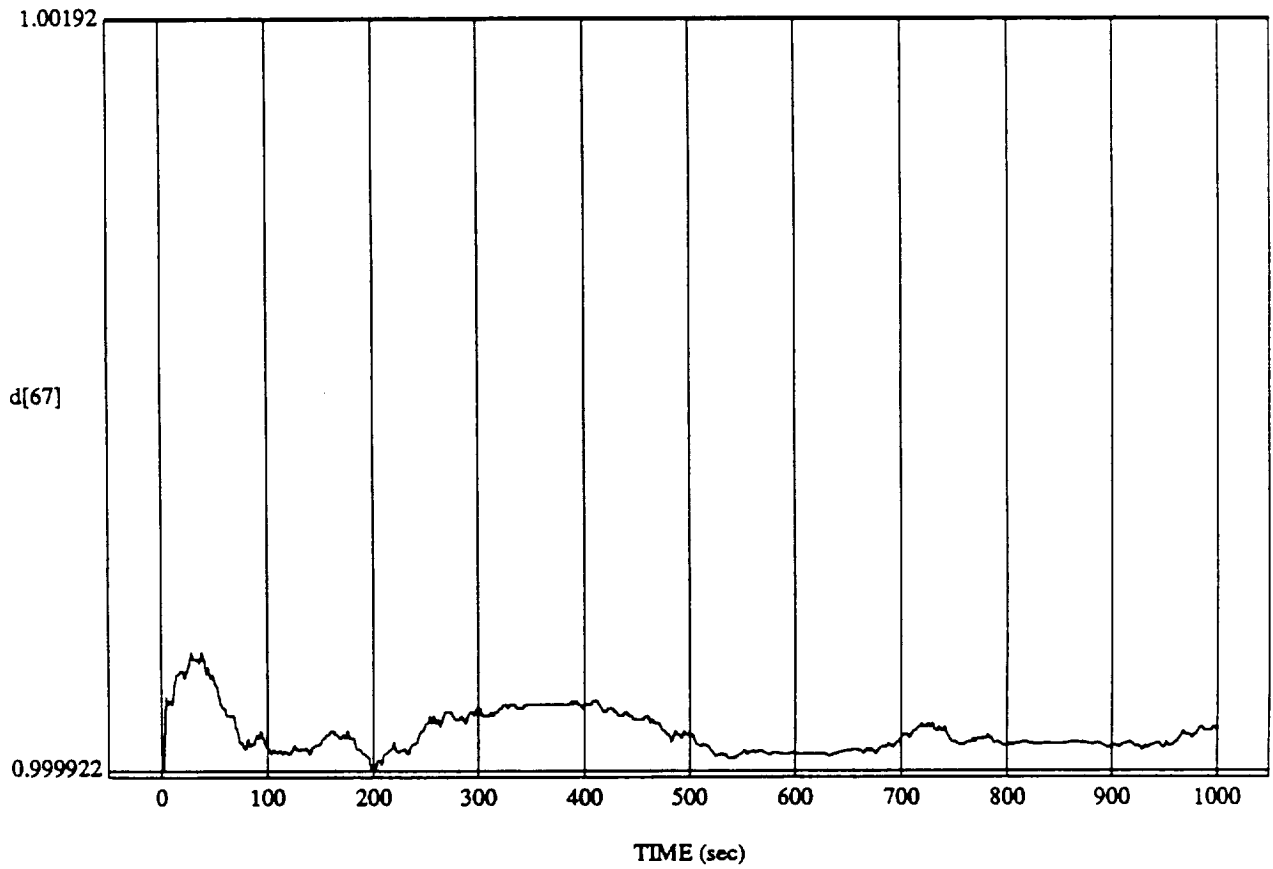
d[66] vs TIME  
RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[67] vs TIME  
RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

ORBITAL OPERATIONS SIMULATOR

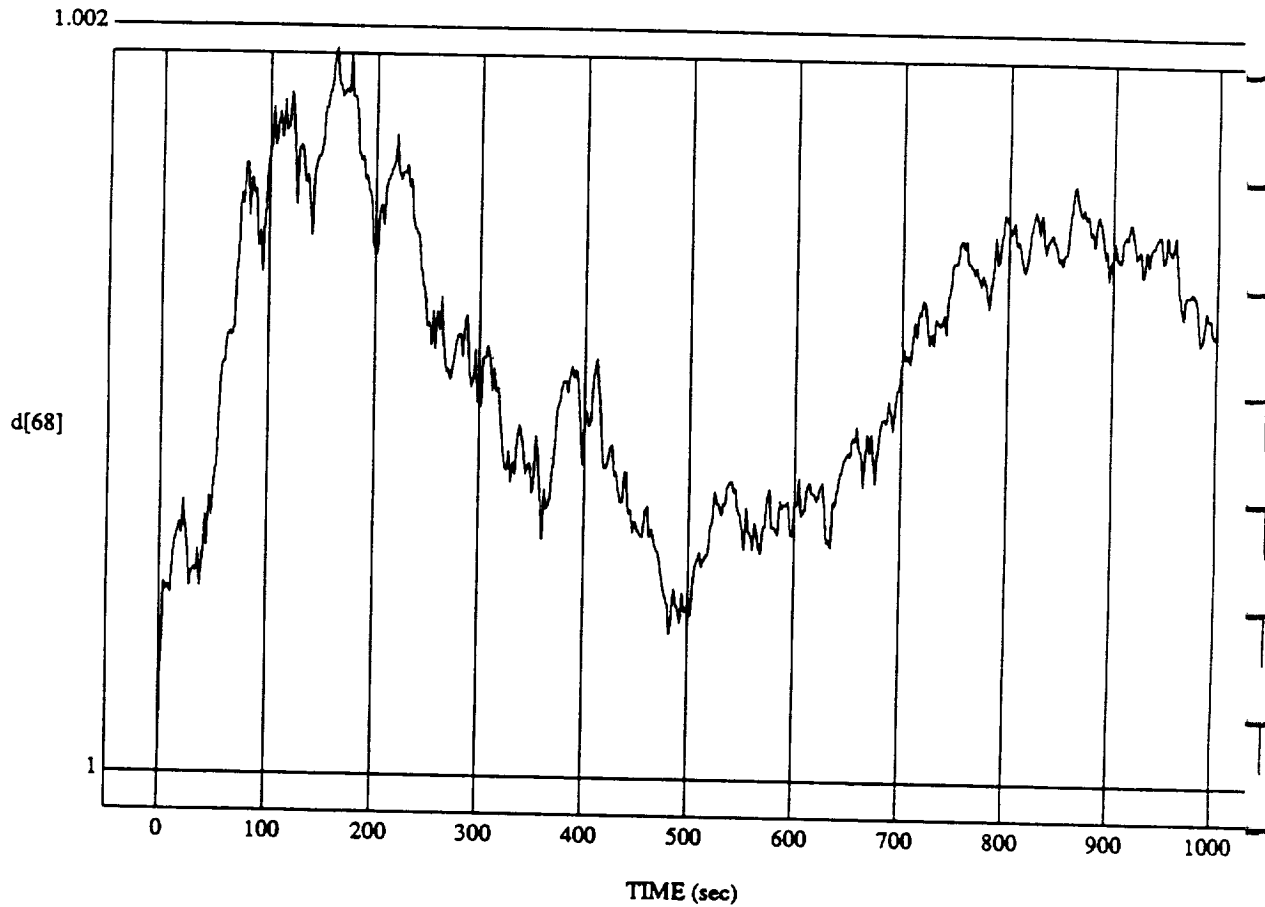
13

Mon May 04 1992 11:30:27 AM

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[68] vs TIME

RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

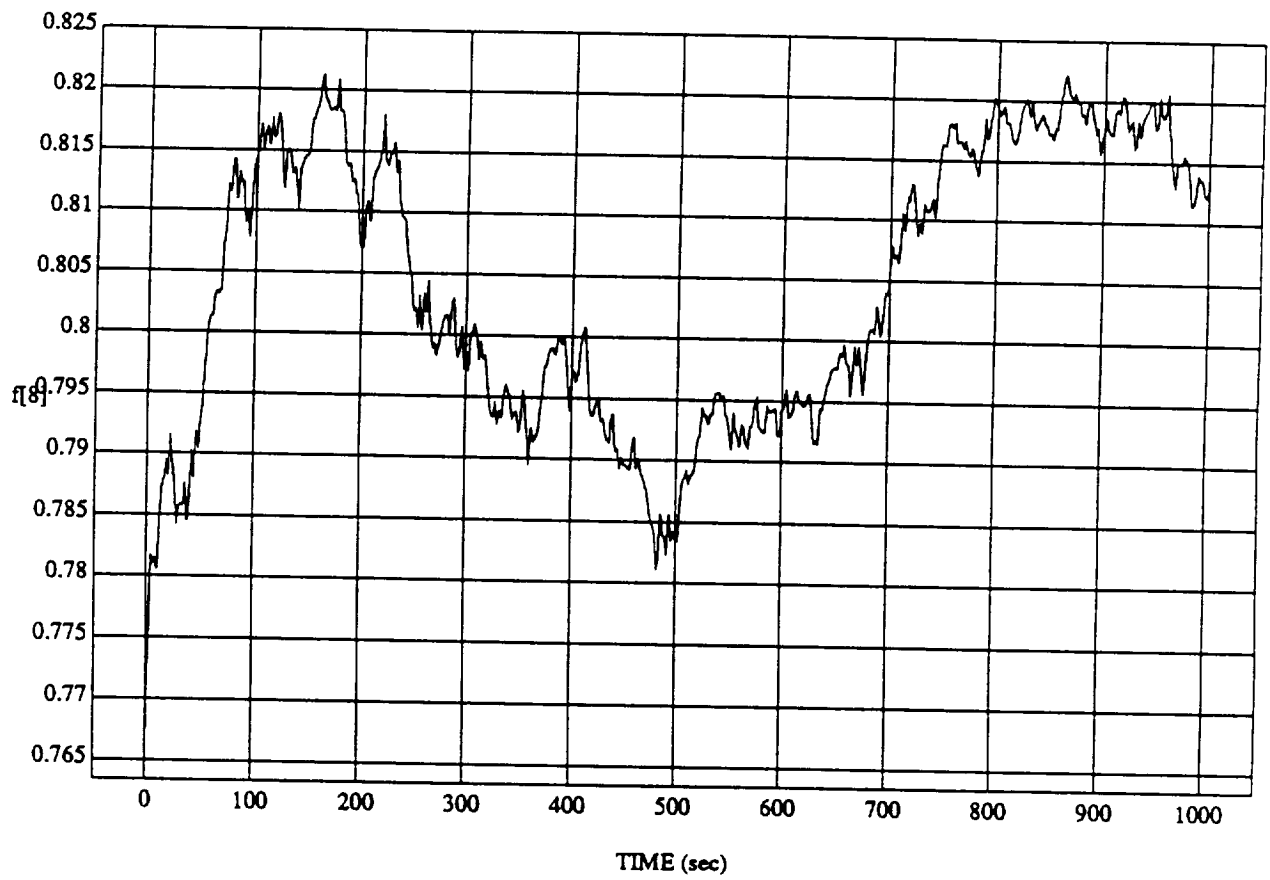
ORBITAL OPERATIONS SIMULATOR

14

Mon May 04 1992 11:30:27 AM

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[8]$  vs TIME  
RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992

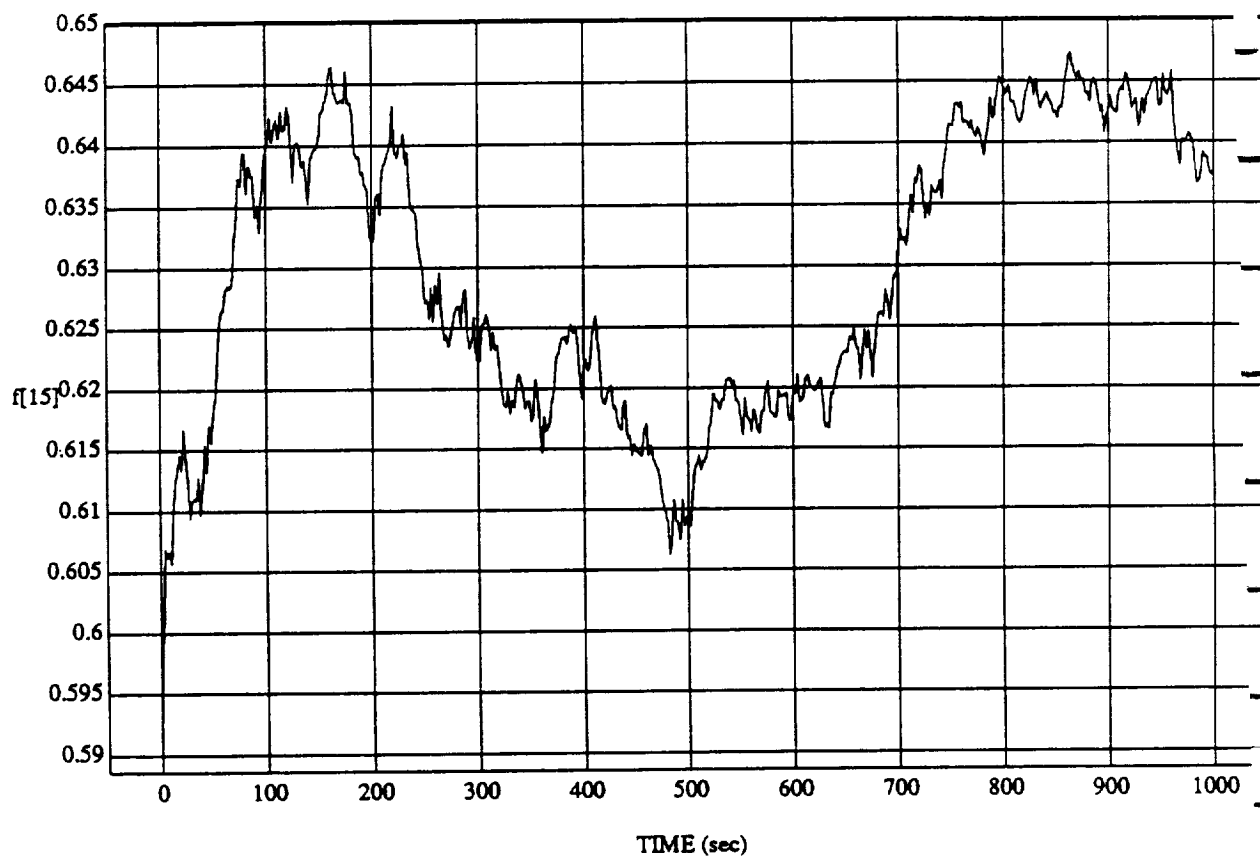


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[15] vs TIME

RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



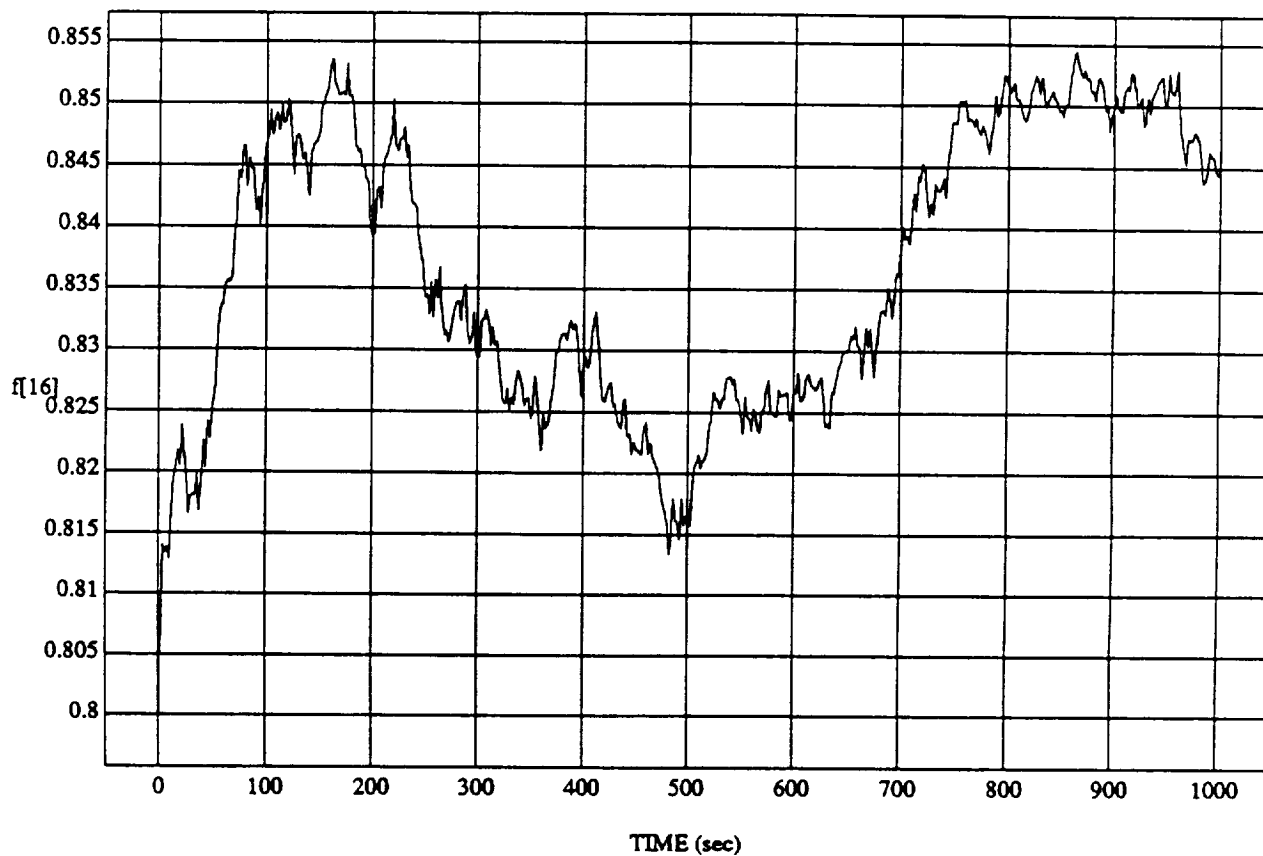
MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[16] vs TIME

RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992

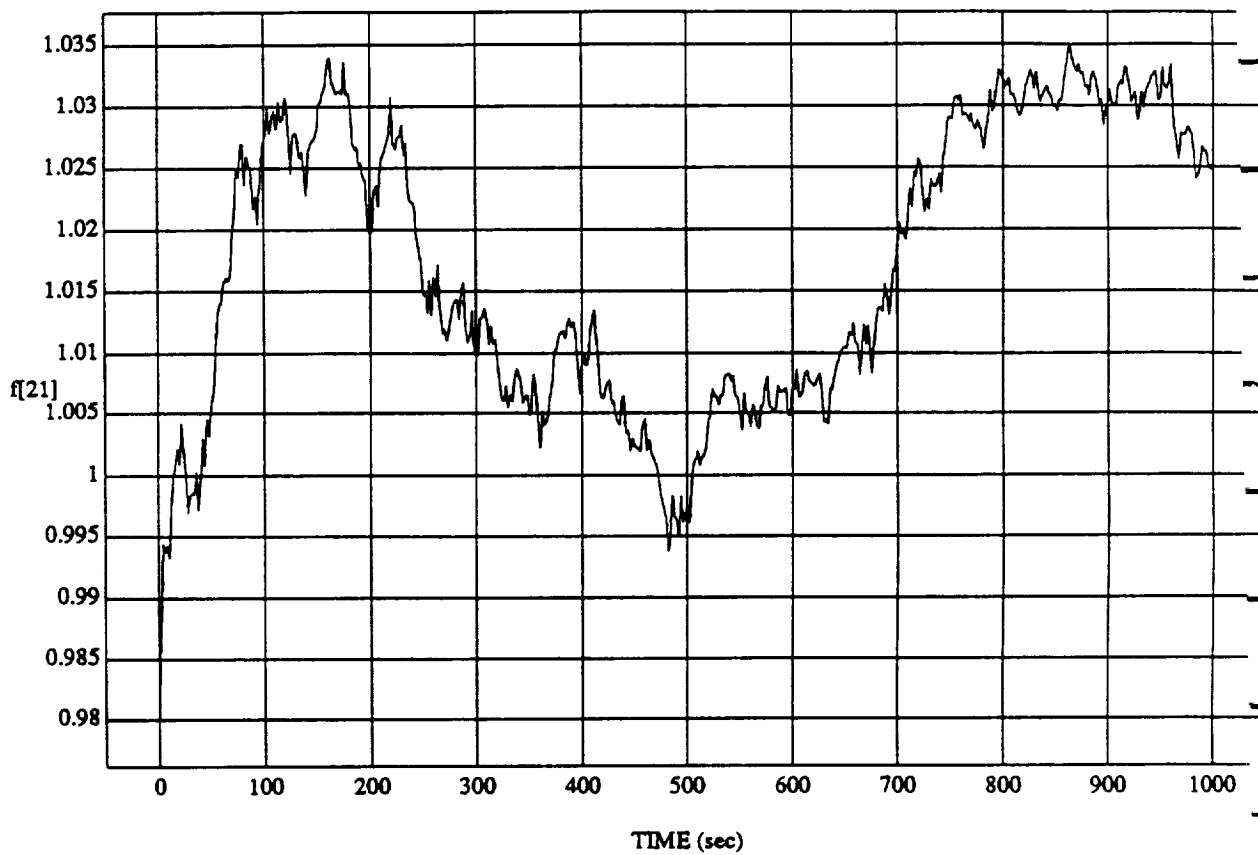


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[21] vs TIME

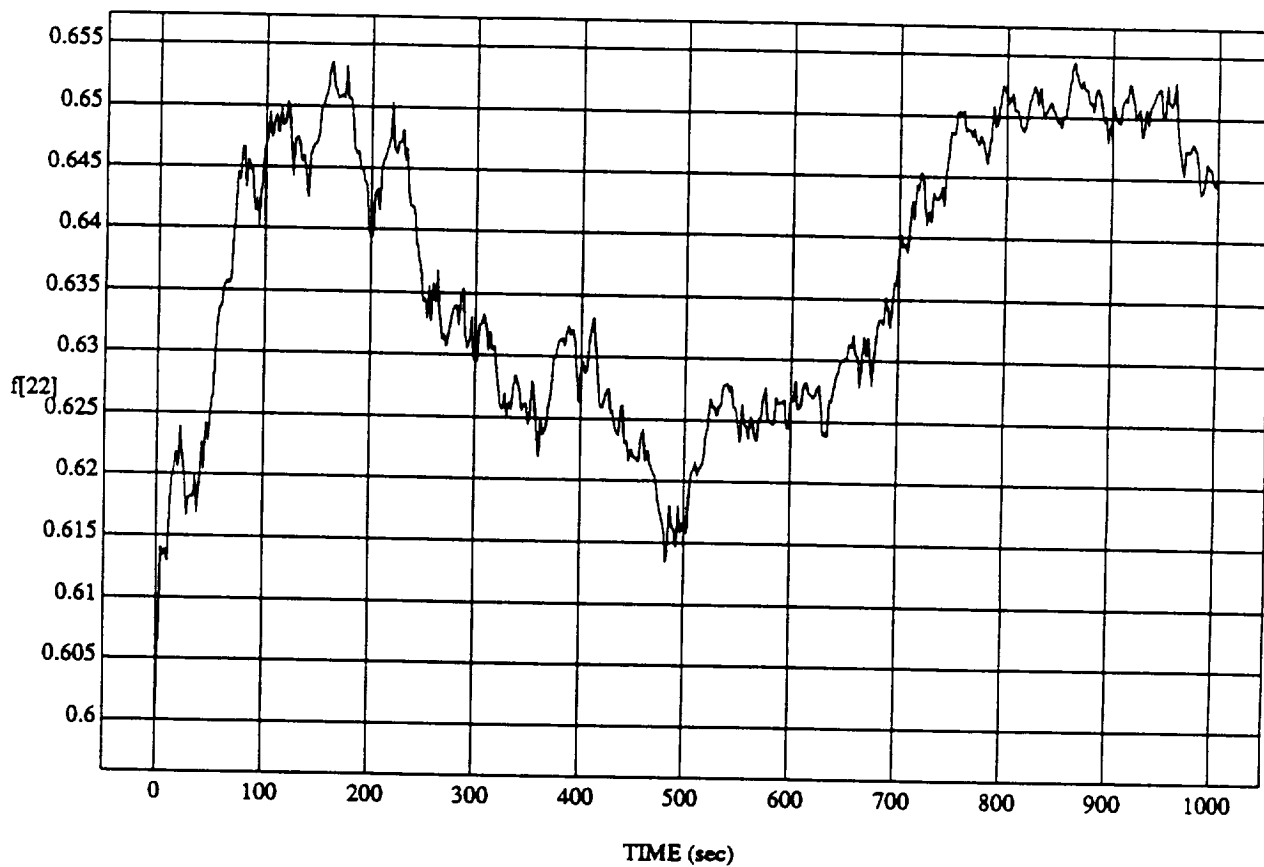
RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[22] vs TIME  
RUN: Fuzzy / NN Learner - Normalized SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



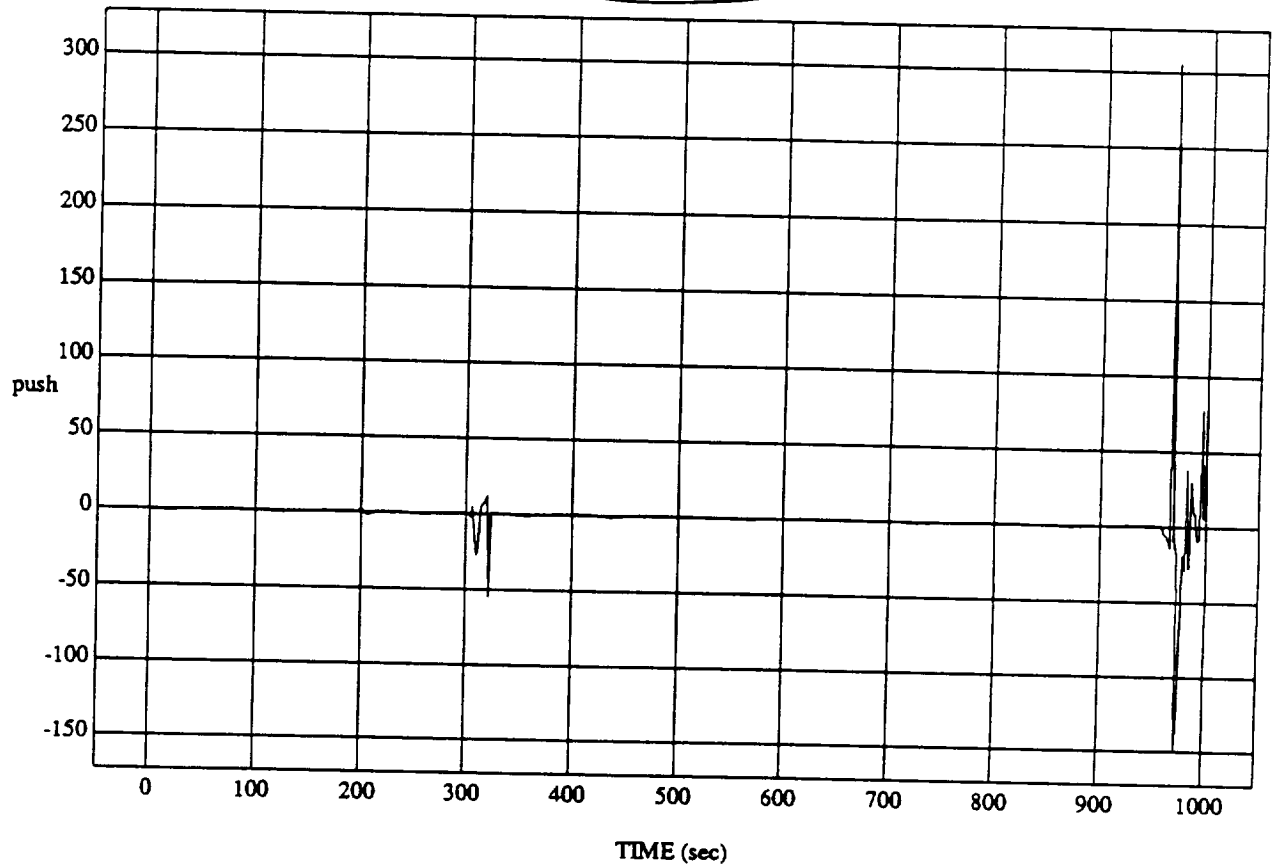




III

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

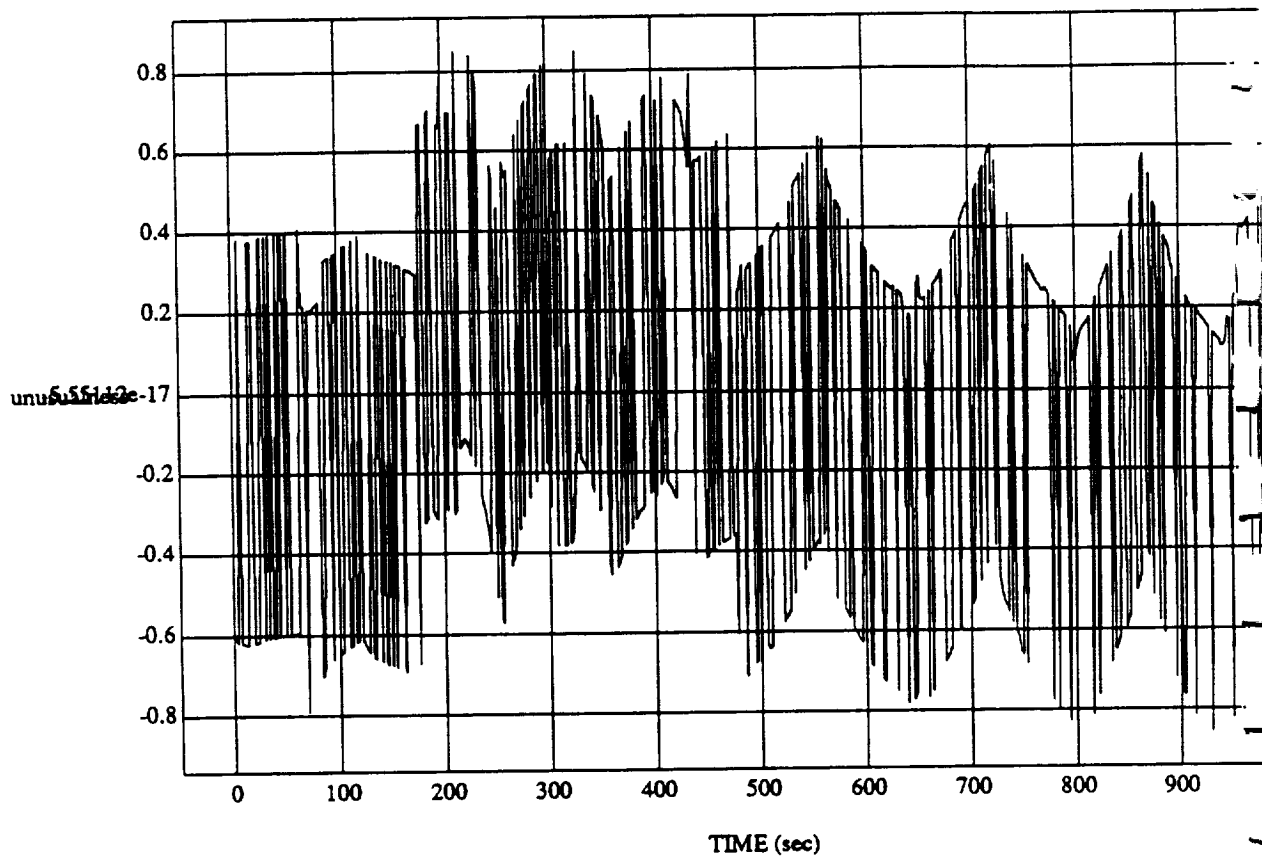
push vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

unusualness vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

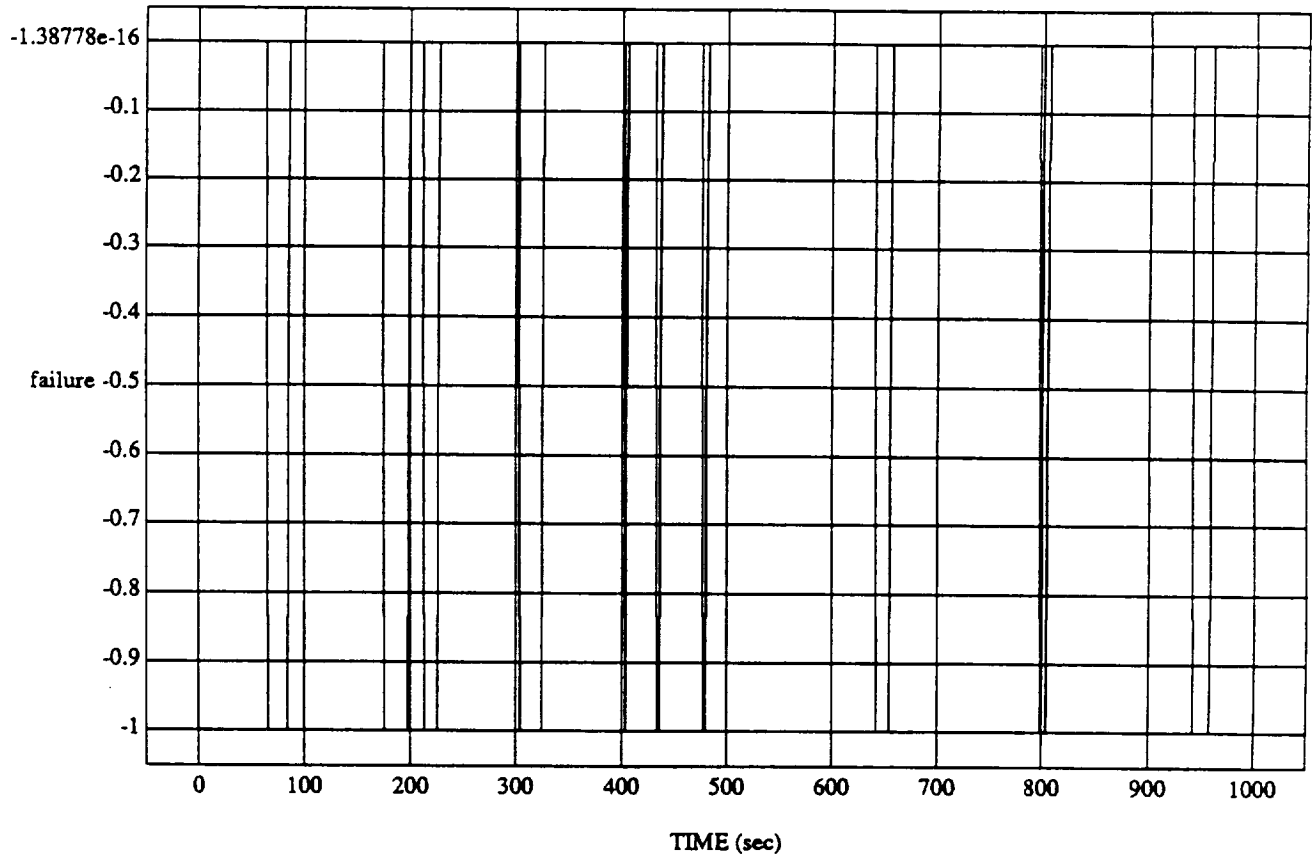
ORBITAL OPERATIONS SIMULATOR

Mon May 04 1992 12:08:31 PM



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

failure vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

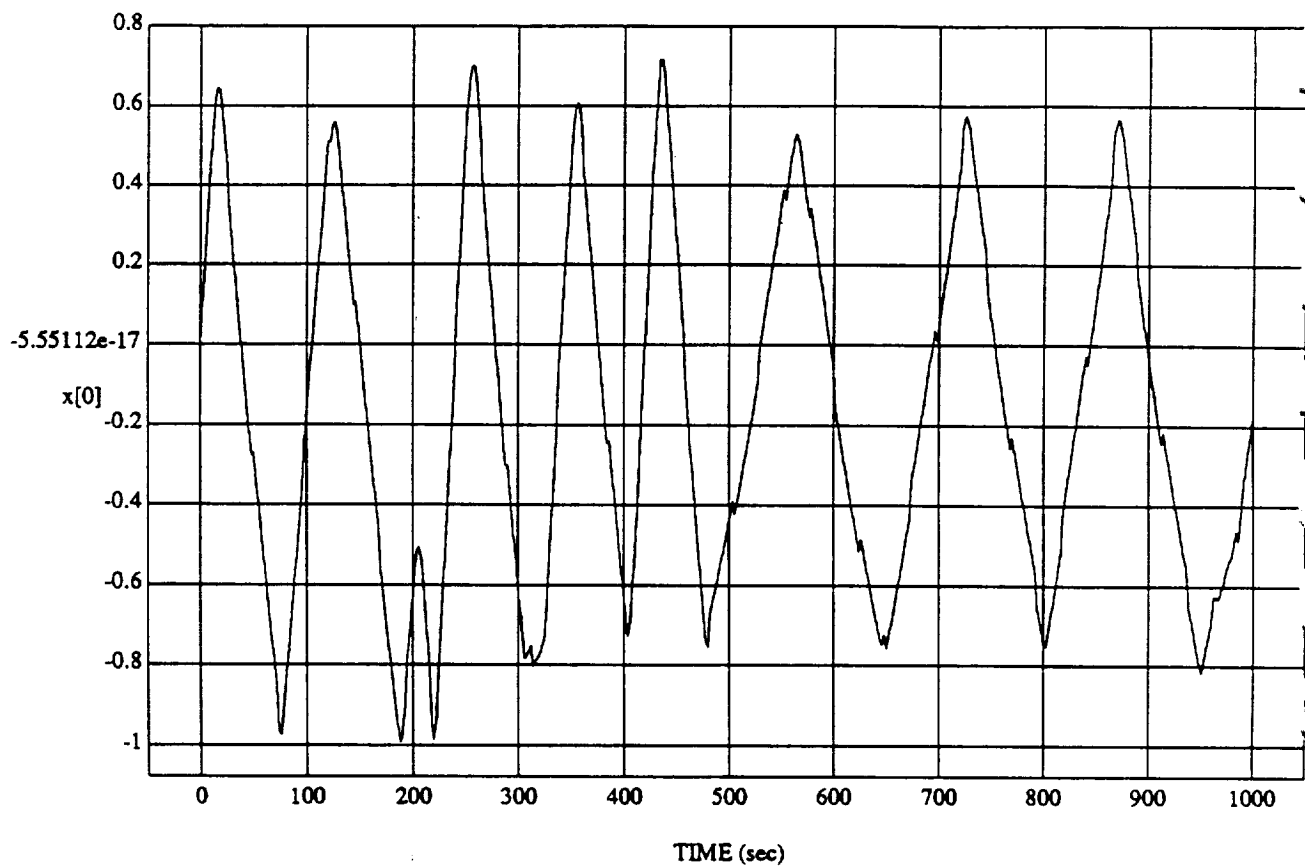


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$x[0]$  vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



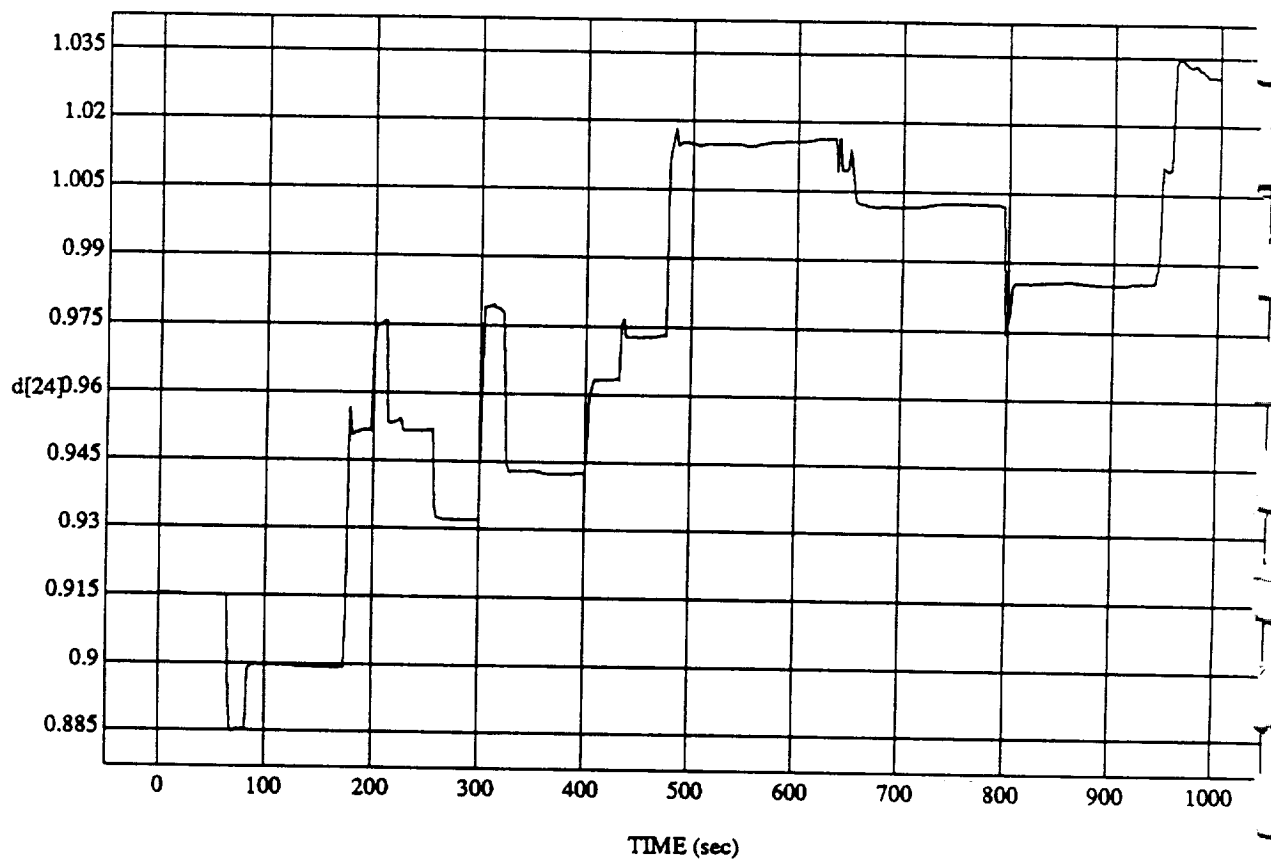
MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

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SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[24] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

ORBITAL OPERATIONS SIMULATOR

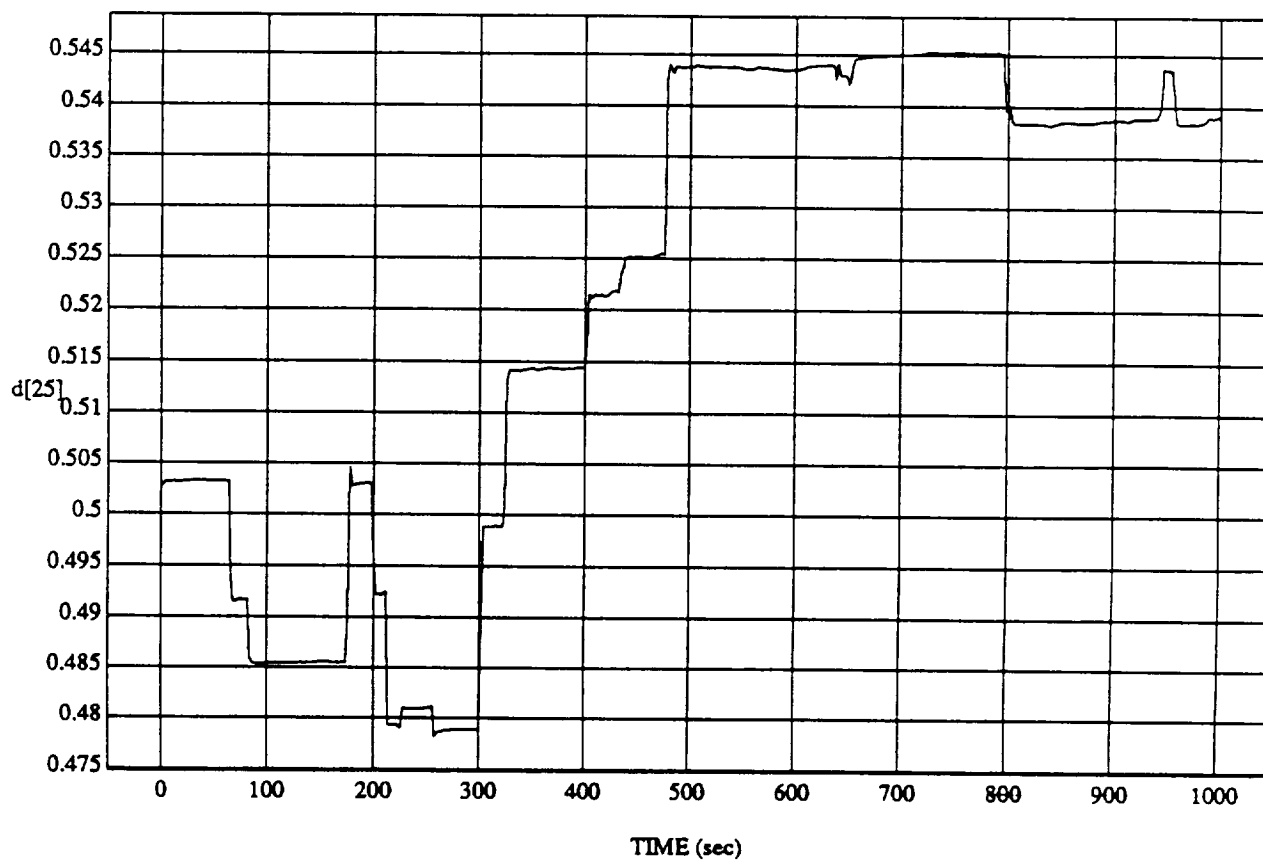
11

Mon May 04 1992 12:08:31 PM

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[25] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lear2

DATA SAMPLING FREQUENCY: 0.500 Hz

ORBITAL OPERATIONS SIMULATOR

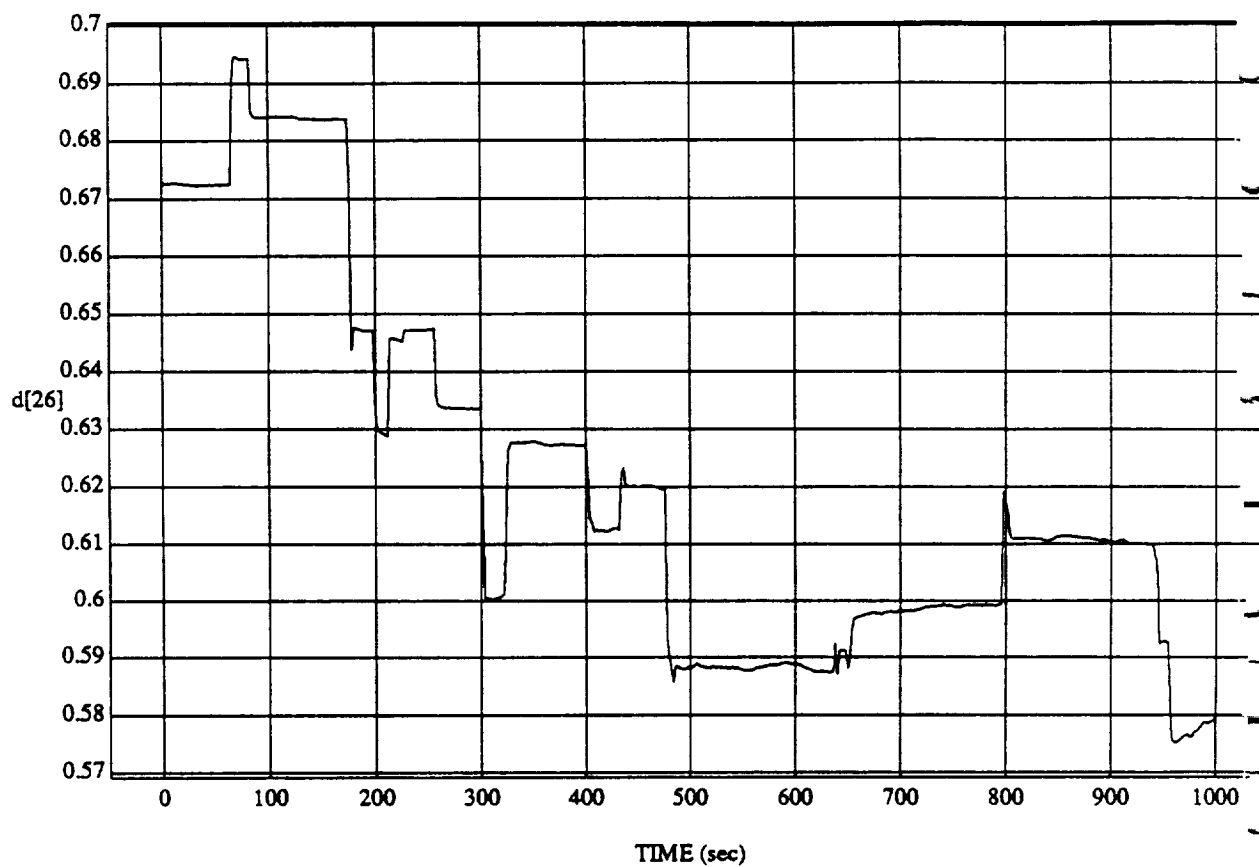
12

Mon May 04 1992 12:08:31 PM

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[26] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

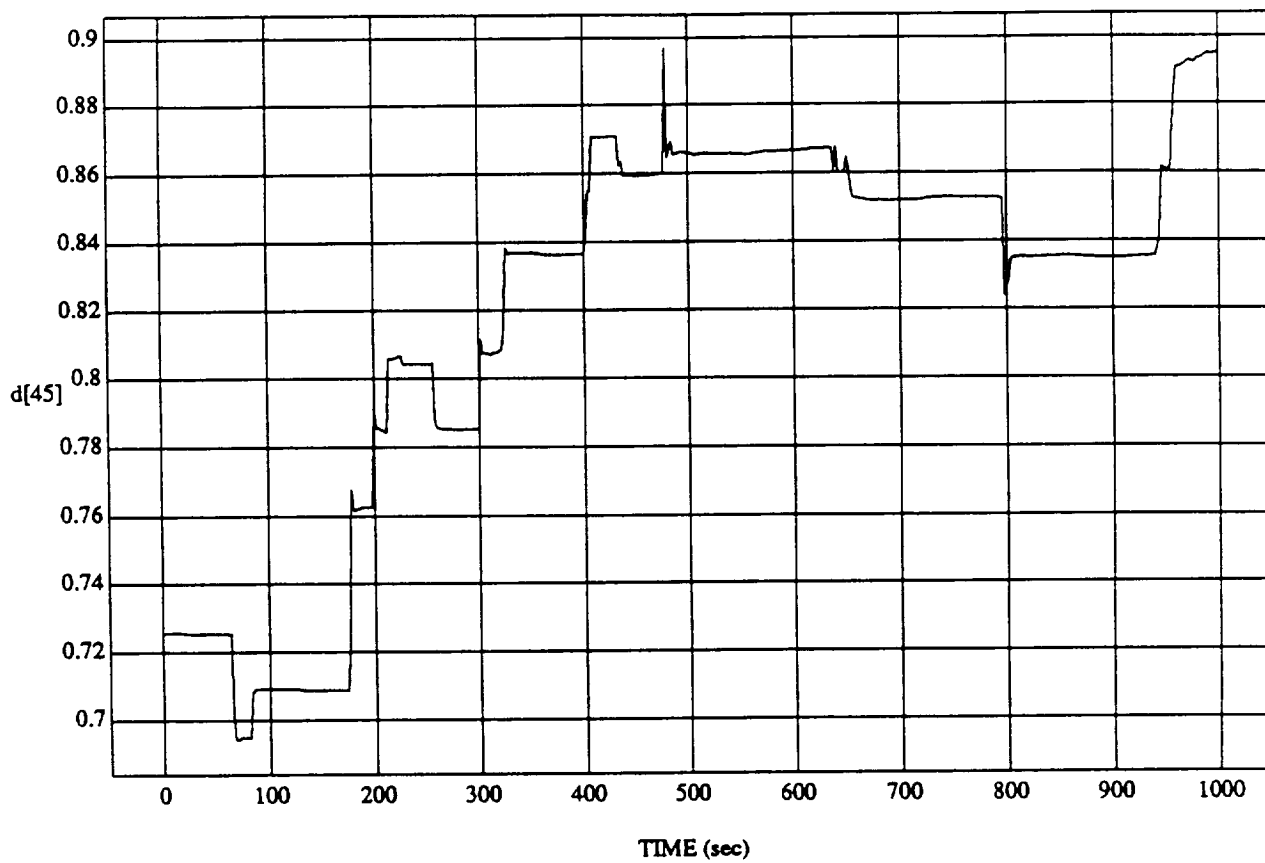


MODULE: ORB\_FUZZ\_BATCHLearn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[45] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

ORBITAL OPERATIONS SIMULATOR

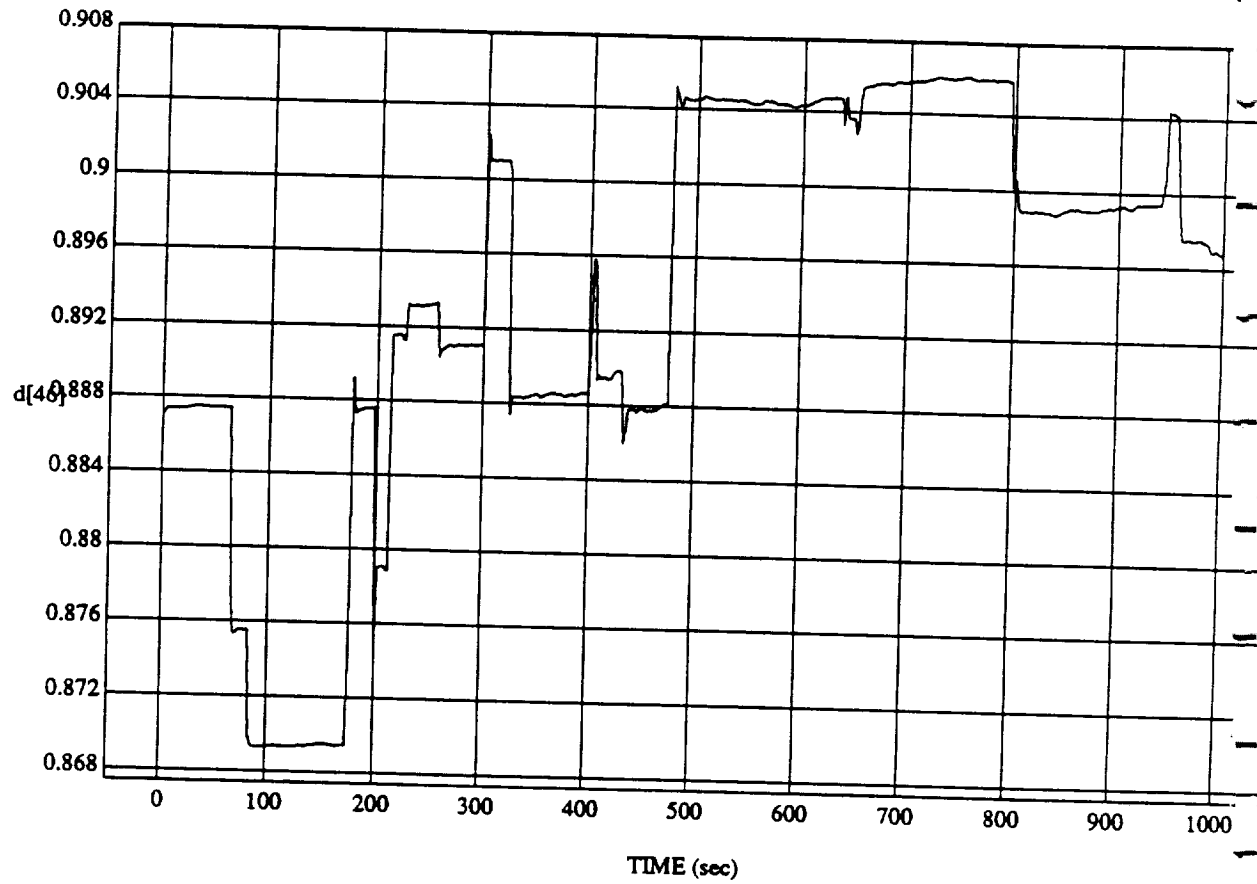
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Mon May 04 1992 12:08:31 PM

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[46] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

ORBITAL OPERATIONS SIMULATOR

15

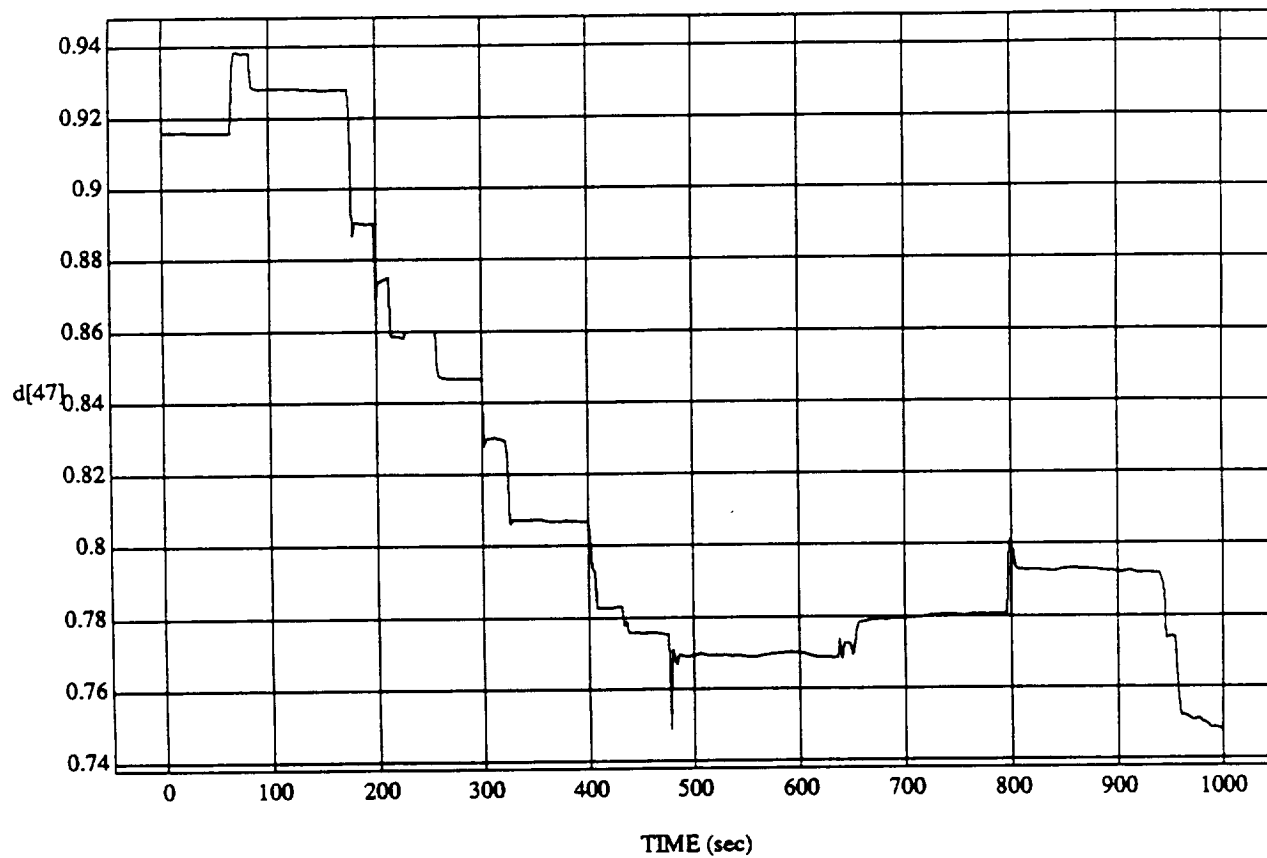
Mon May 04 1992 12:08:31 PM



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[47] vs TIME

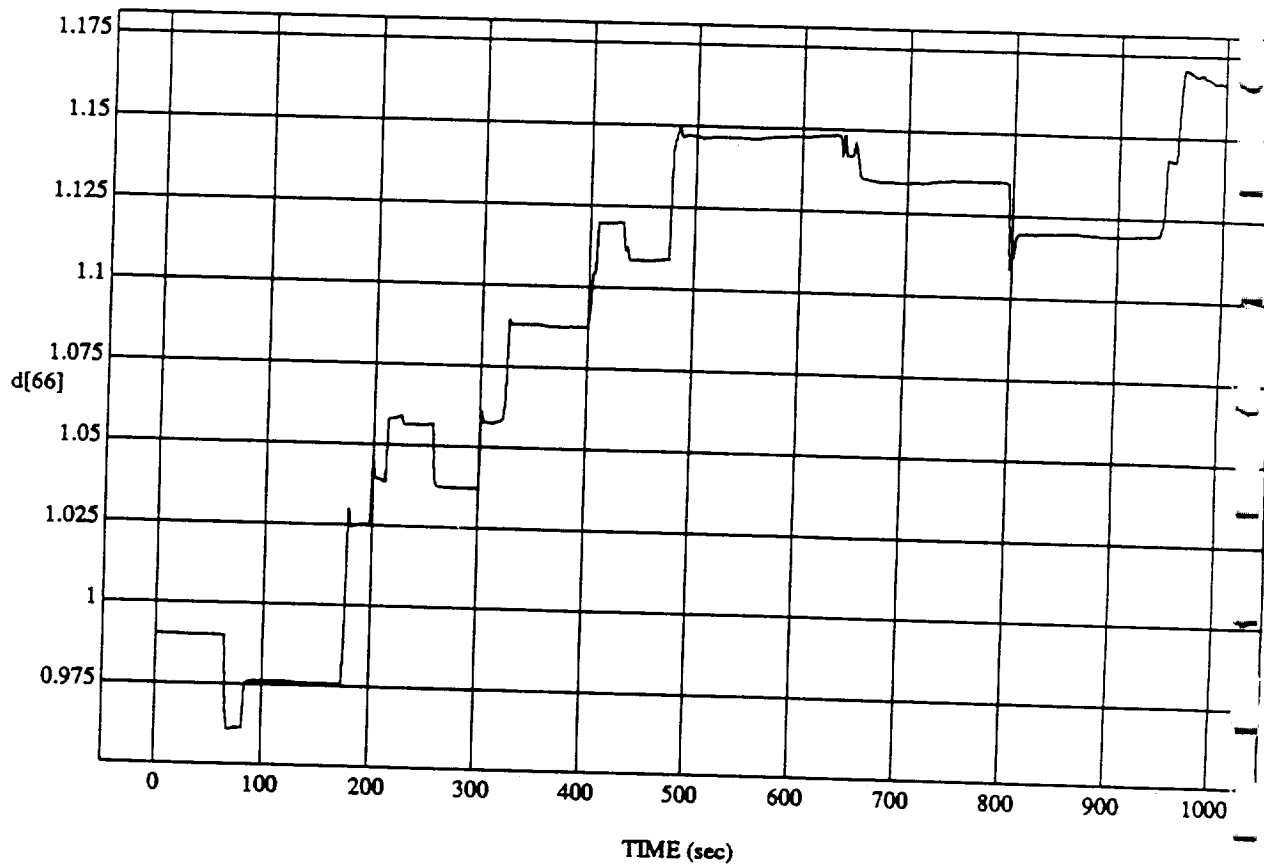
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[66] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lem2  
DATA SAMPLING FREQUENCY: 0.500 Hz

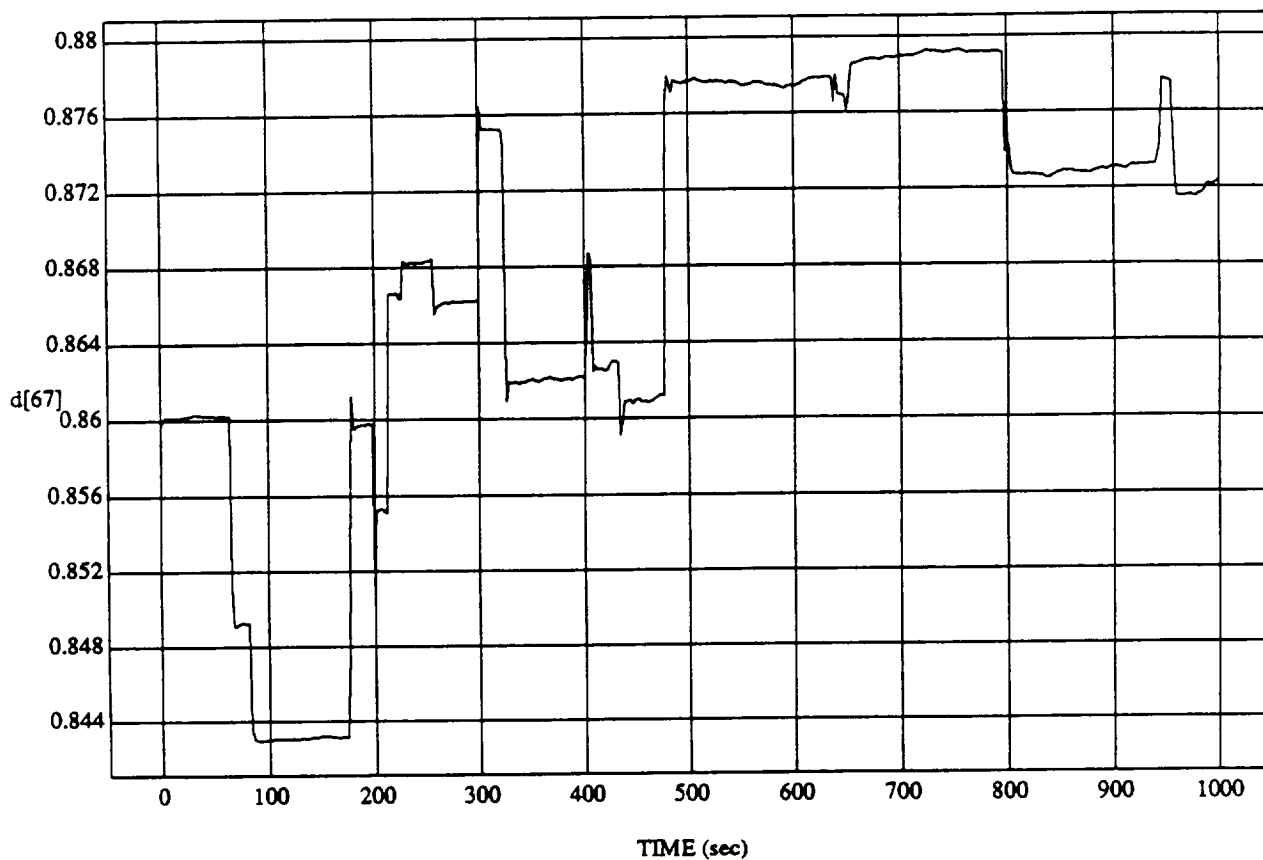
ORBITAL OPERATIONS SIMULATOR

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Mon May 04 1992 12:08:31 PM

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[67] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

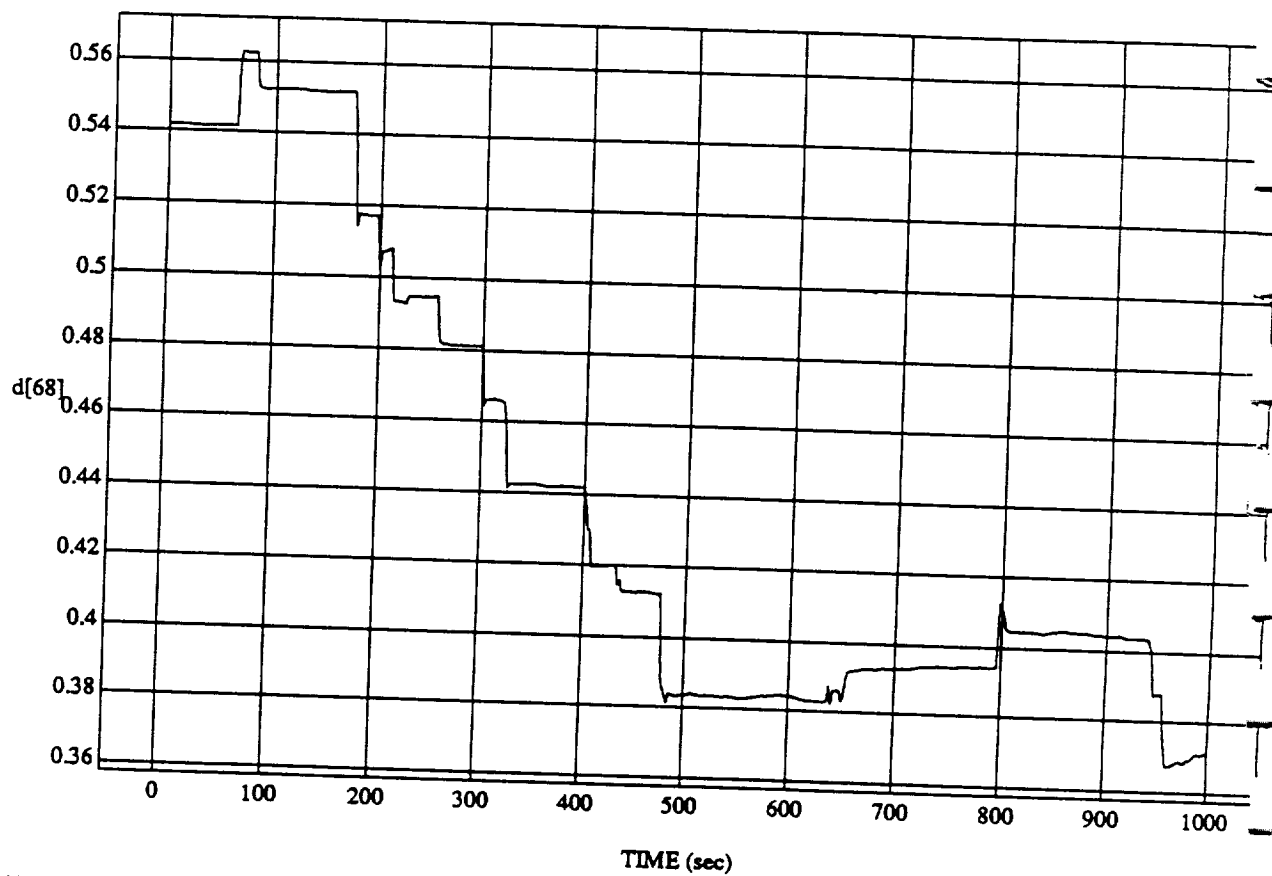


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[68] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

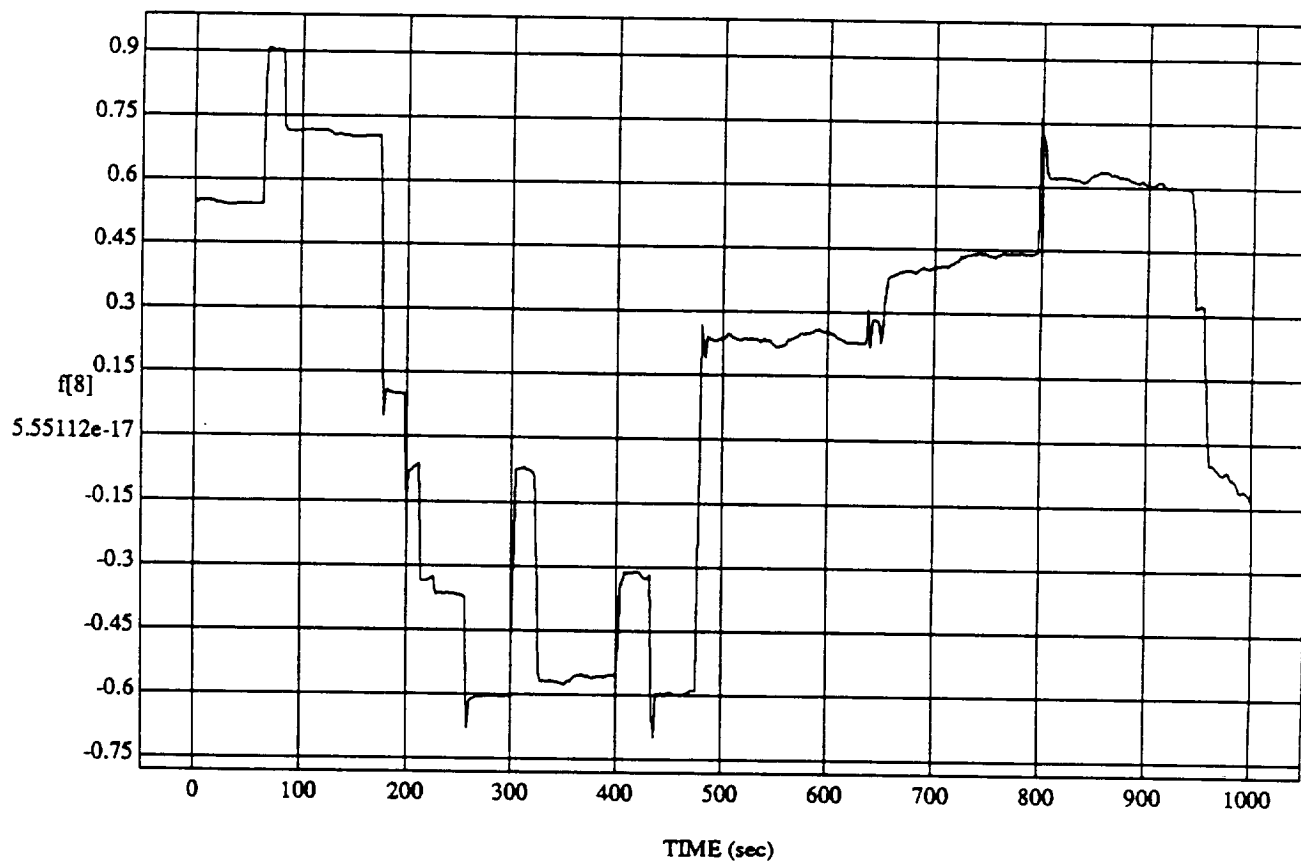
ORBITAL OPERATIONS SIMULATOR

19

Mon May 04 1992 12:08:31 PM

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[8]$  vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

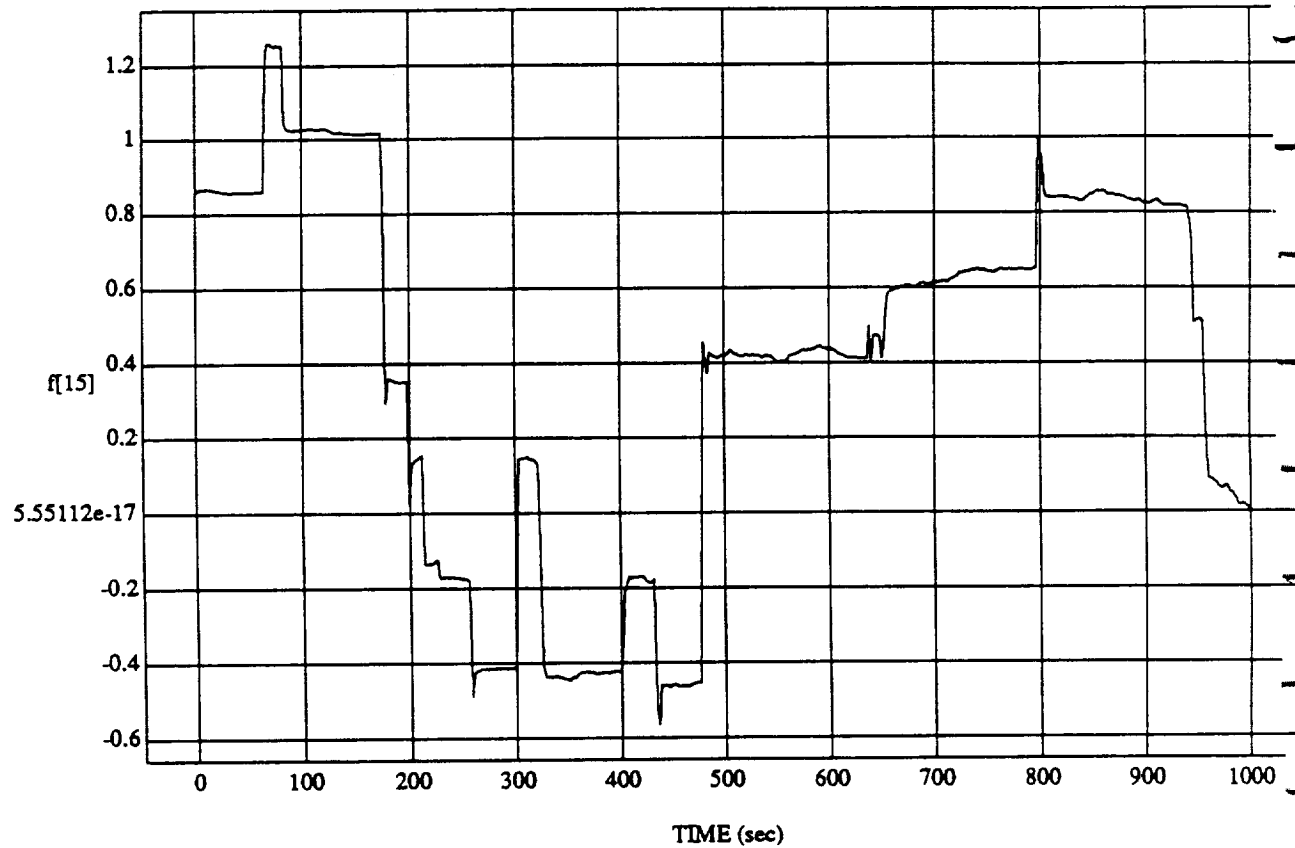


MODULE: ORB\_FUZZ\_BATCH.lcam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[15] vs TIME

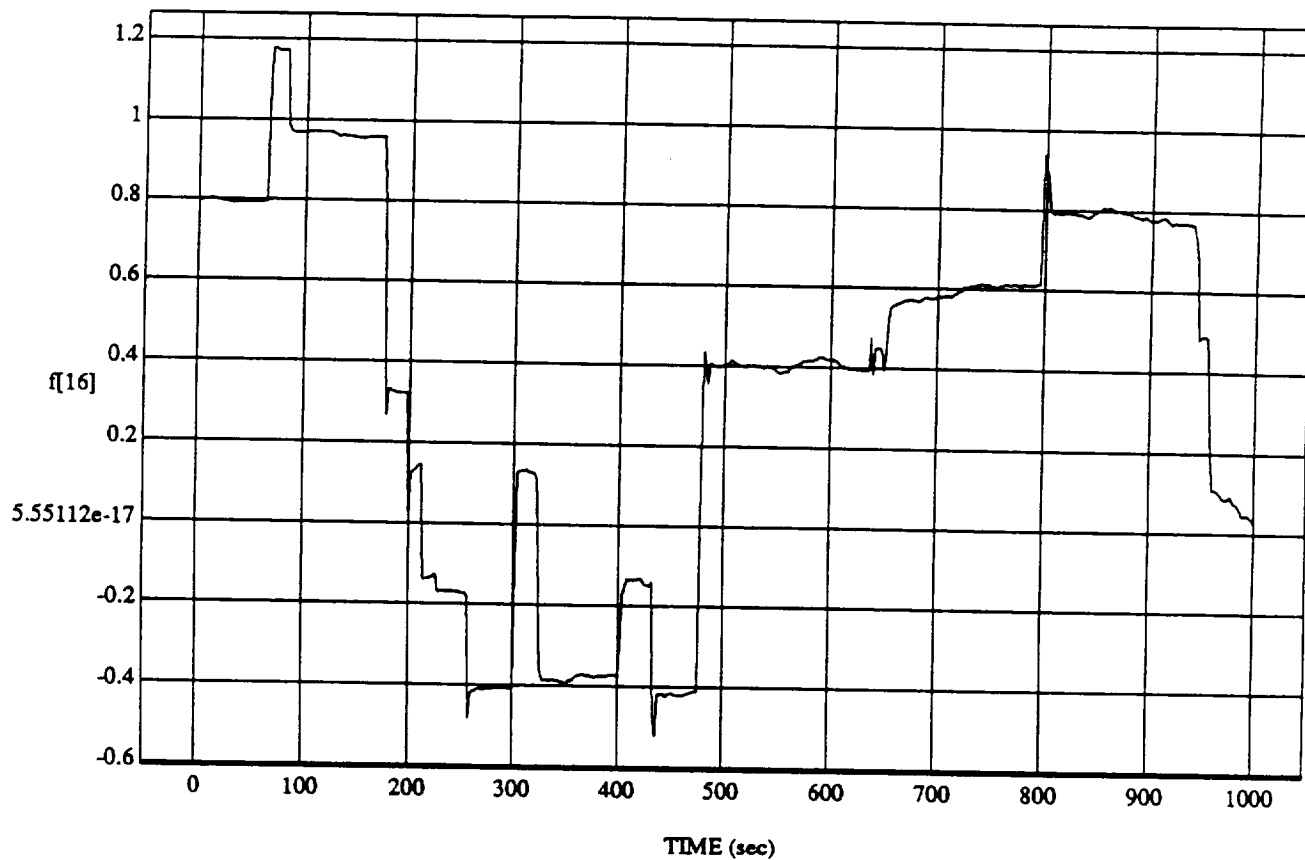
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

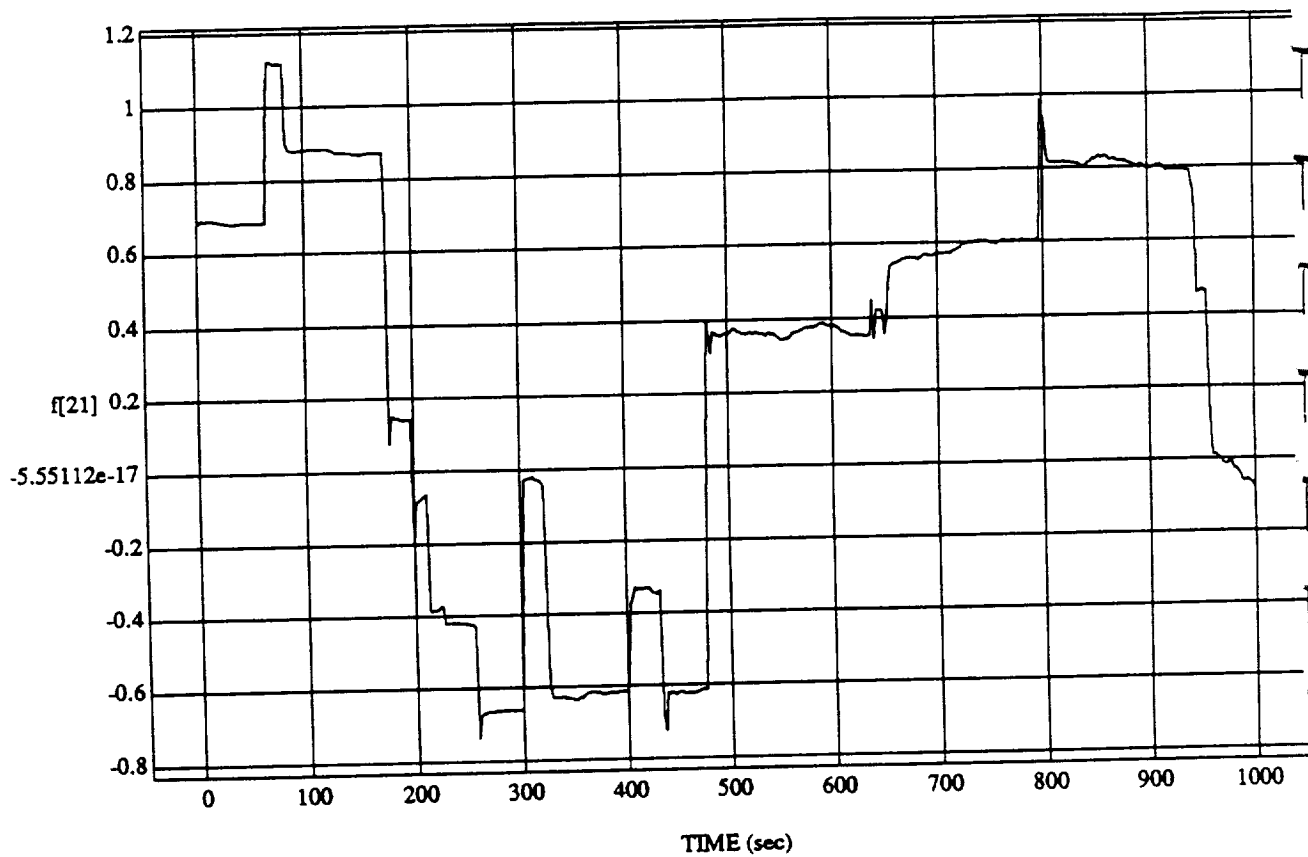
f[16] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[21] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

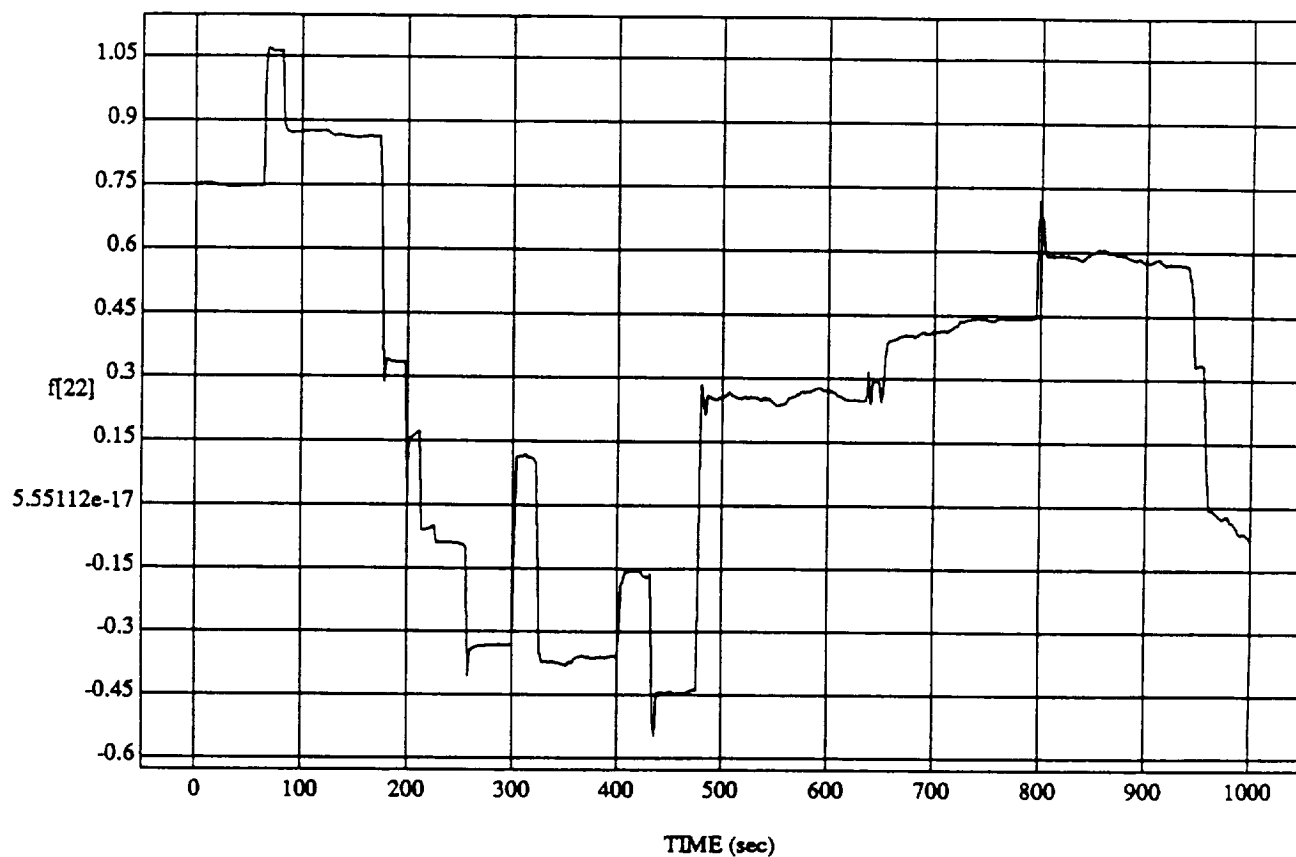


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[22]$  vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz



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if  $L \rightarrow \text{down}$  /  $< 0.01$  then  $L \rightarrow \text{up}$

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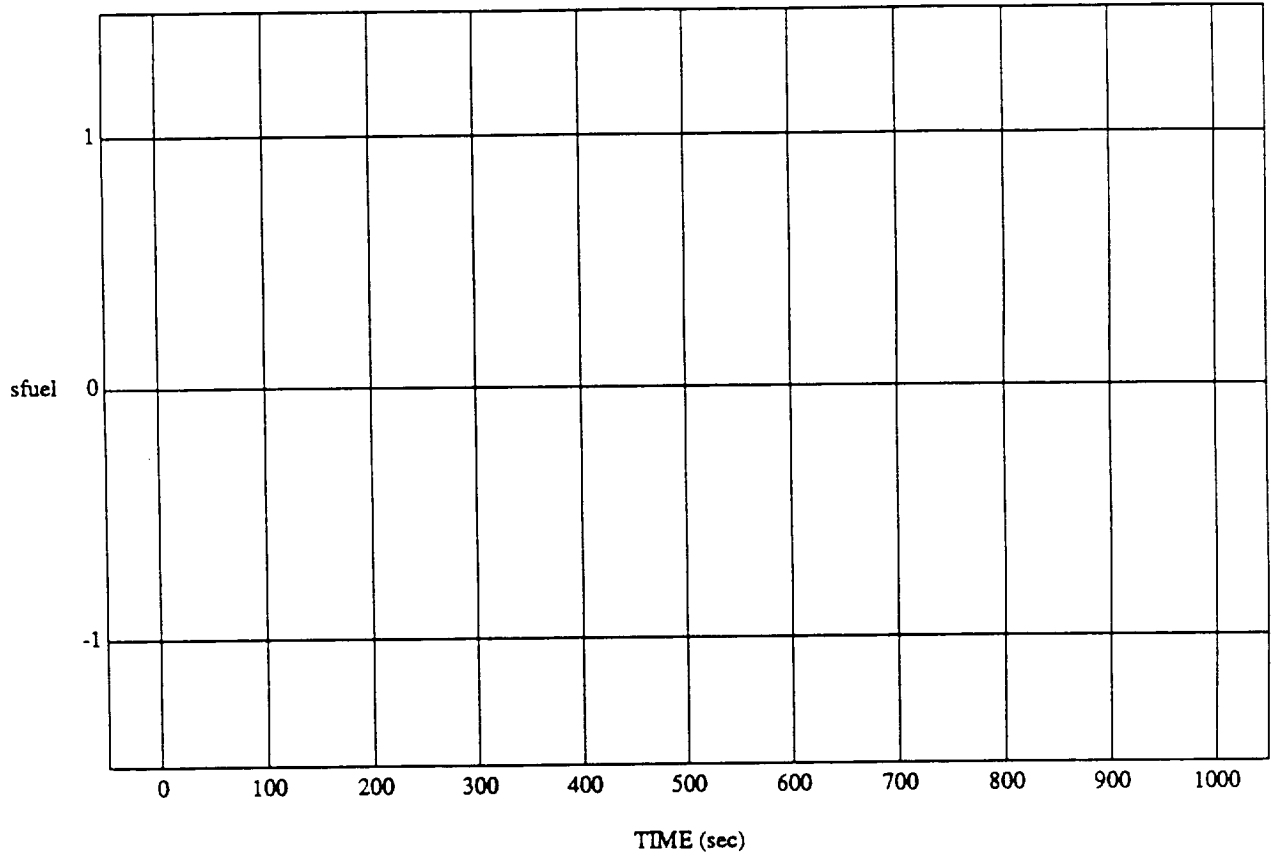
SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

TV

not around .9

sfuel vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

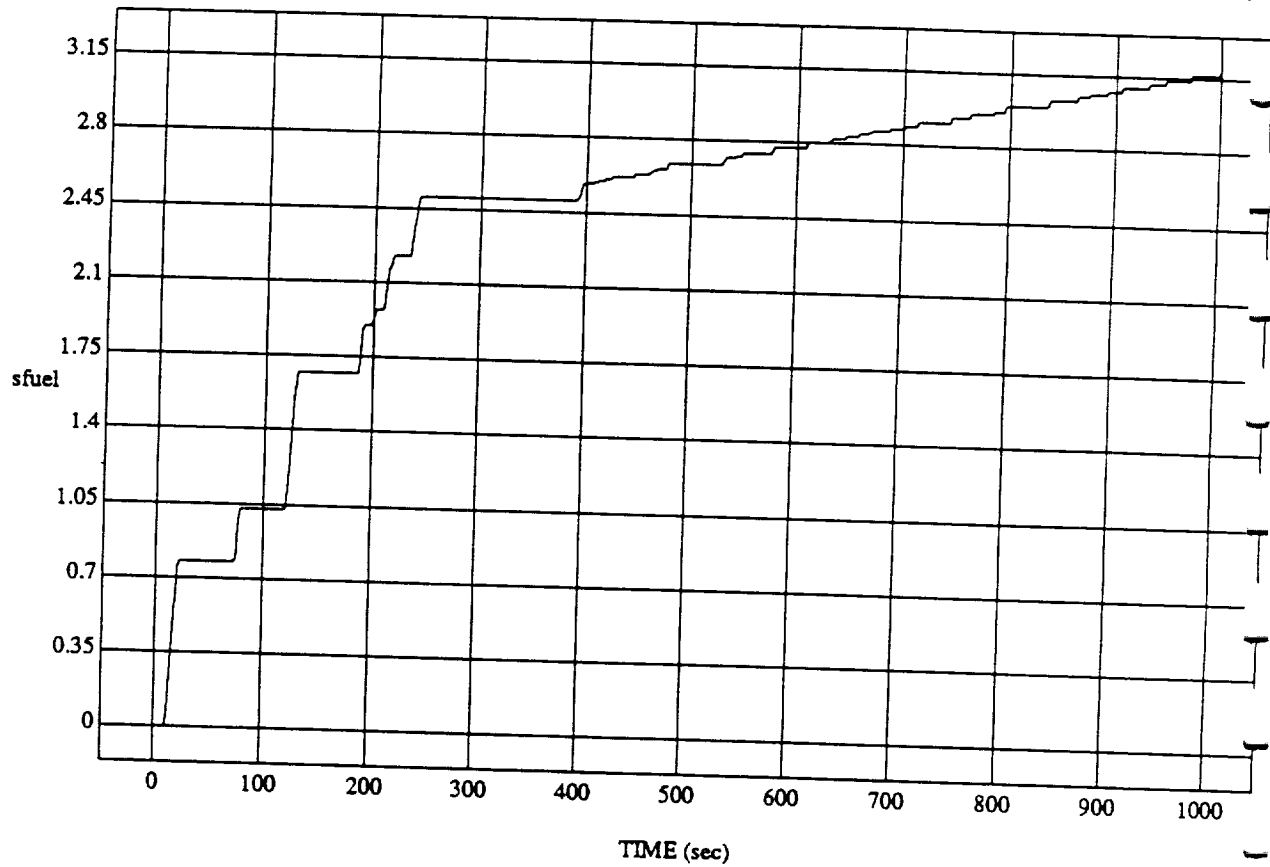


MODULE: ORB\_FUZZ\_BATCH.primary  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

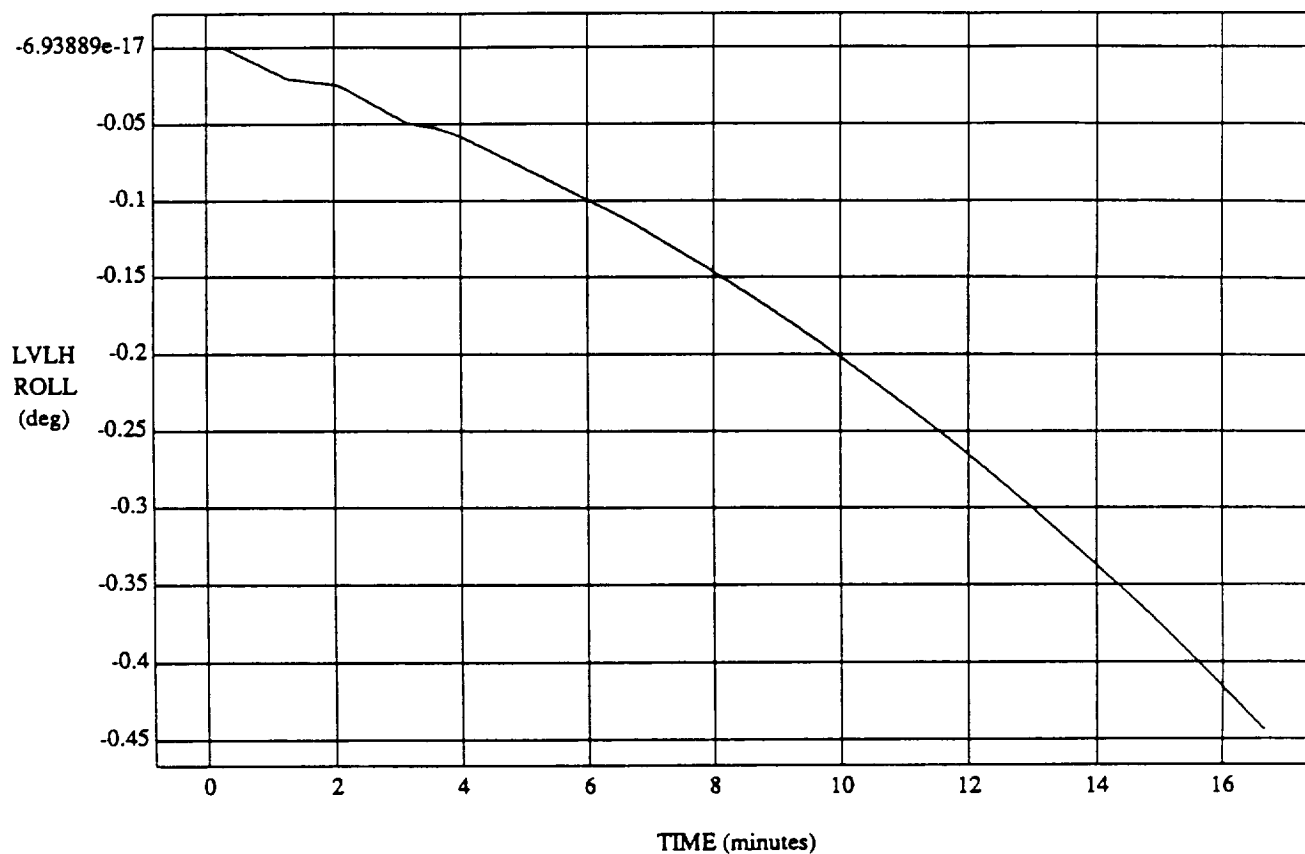


MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

# LVLH EULER PYR ROLL vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

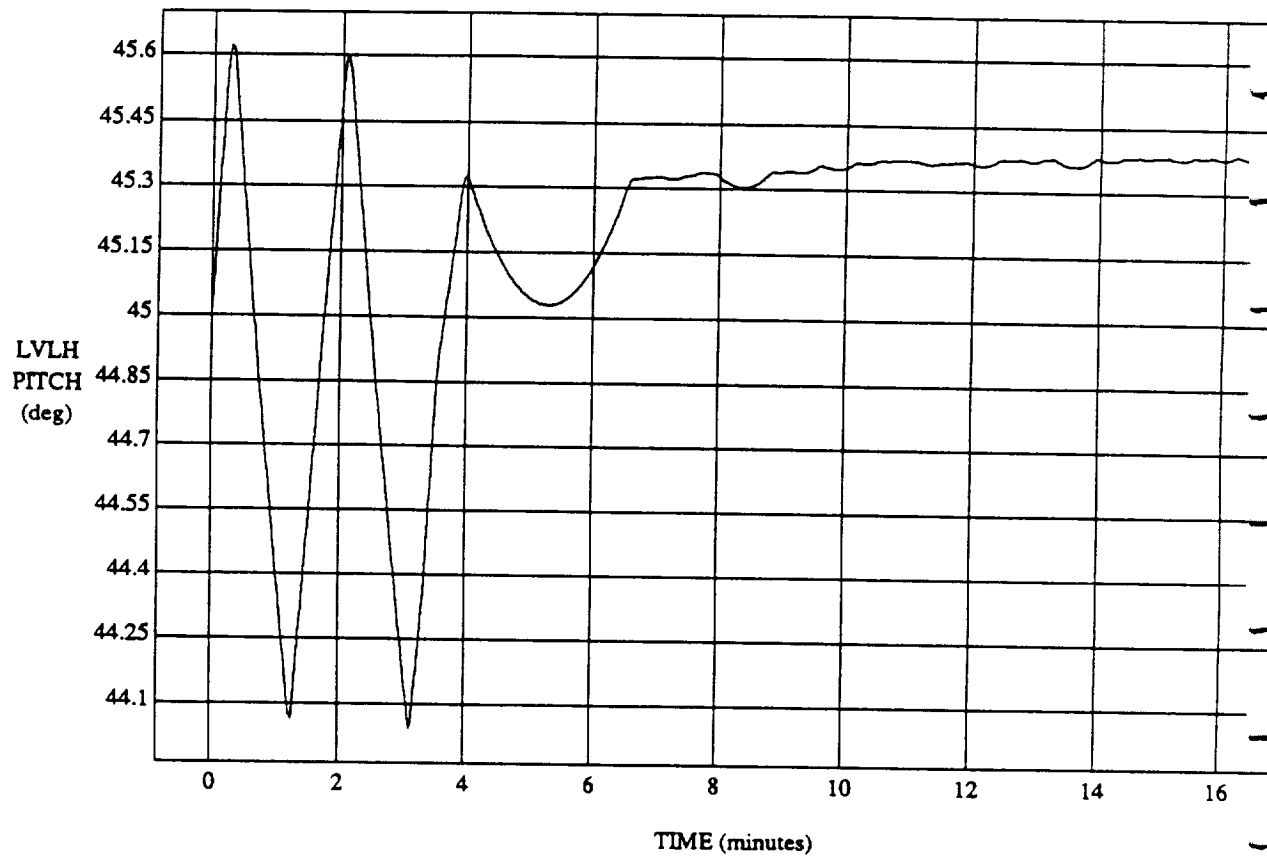


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

# LVLH EULER PYR PITCH vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

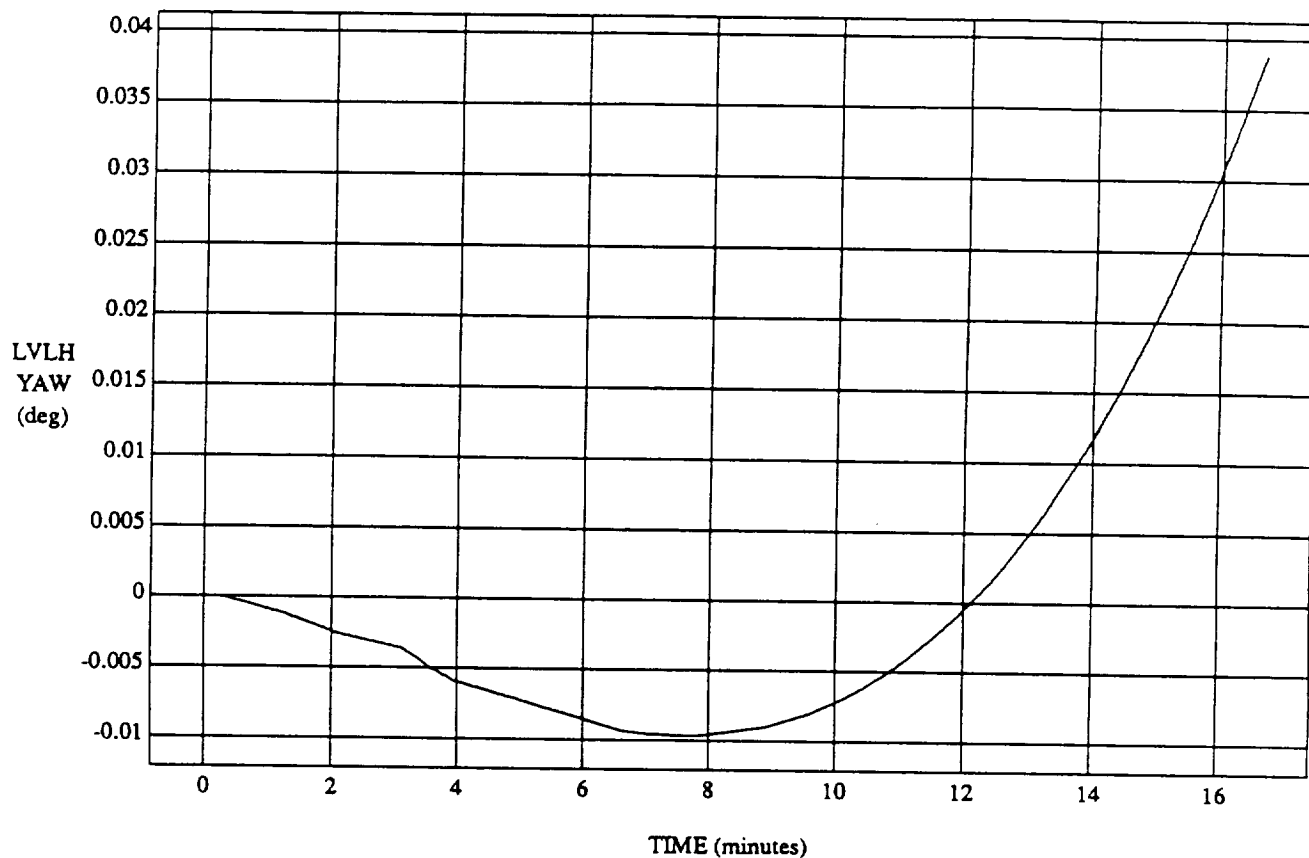


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz



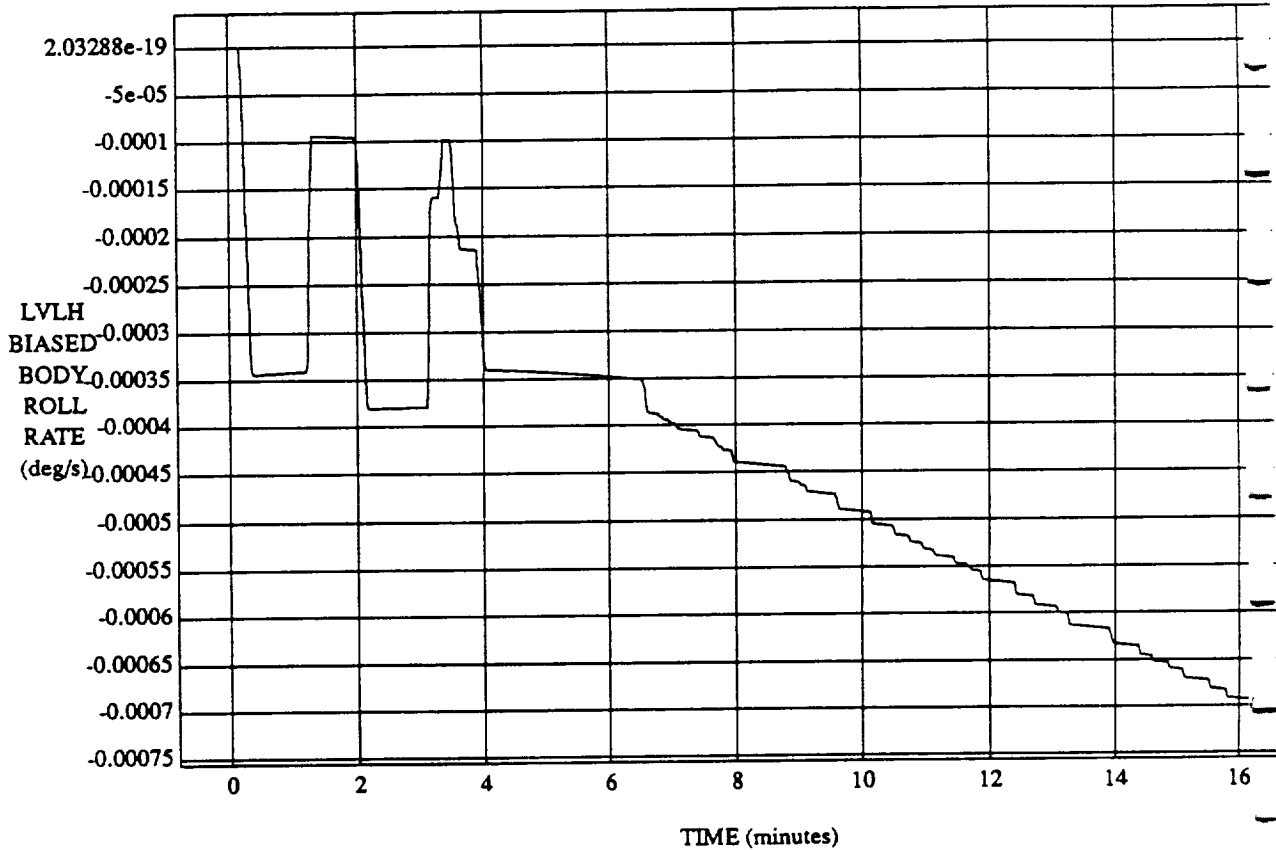
SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH EULER PYR YAW vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

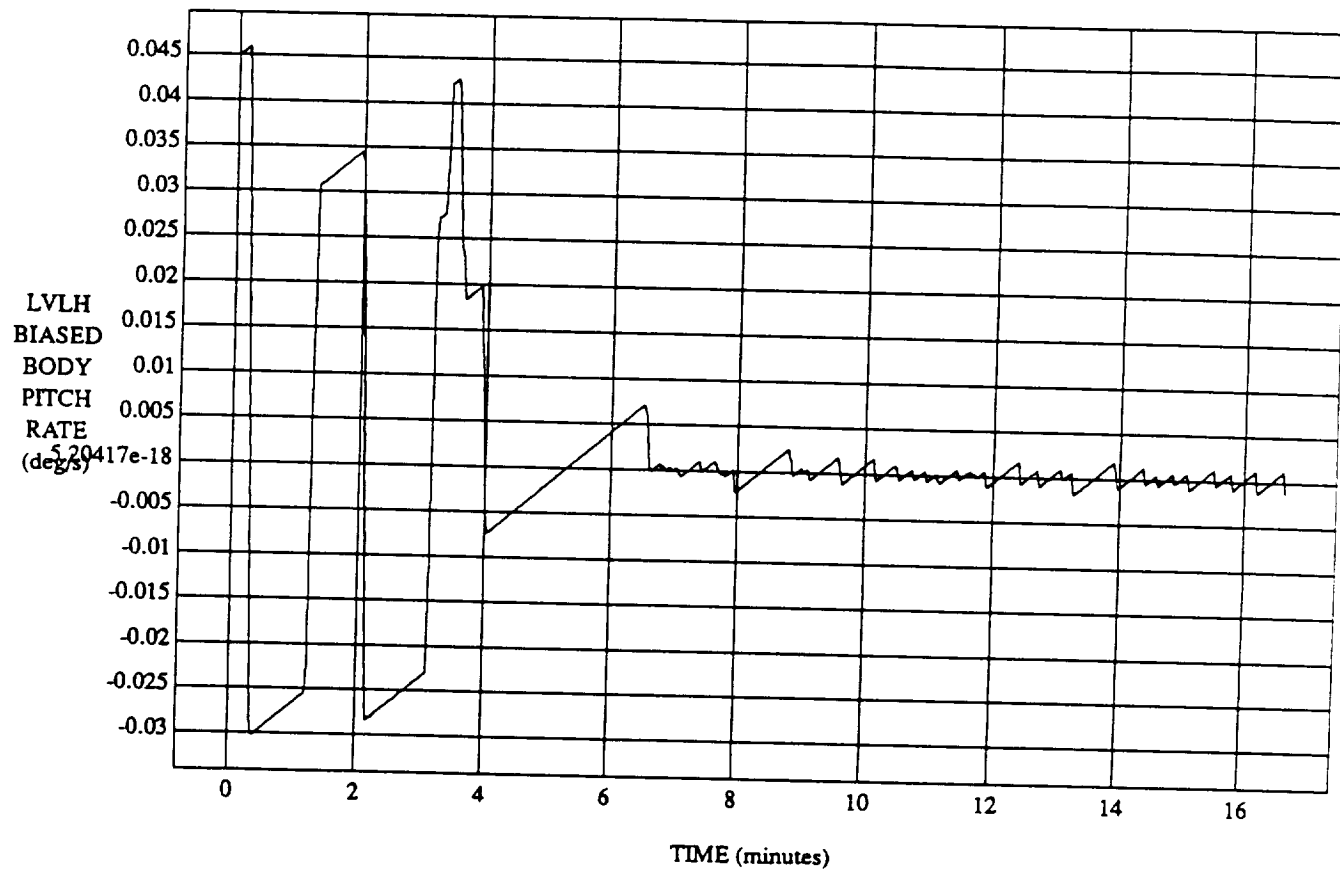
LVLH BIASED BODY ROLL RATE vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

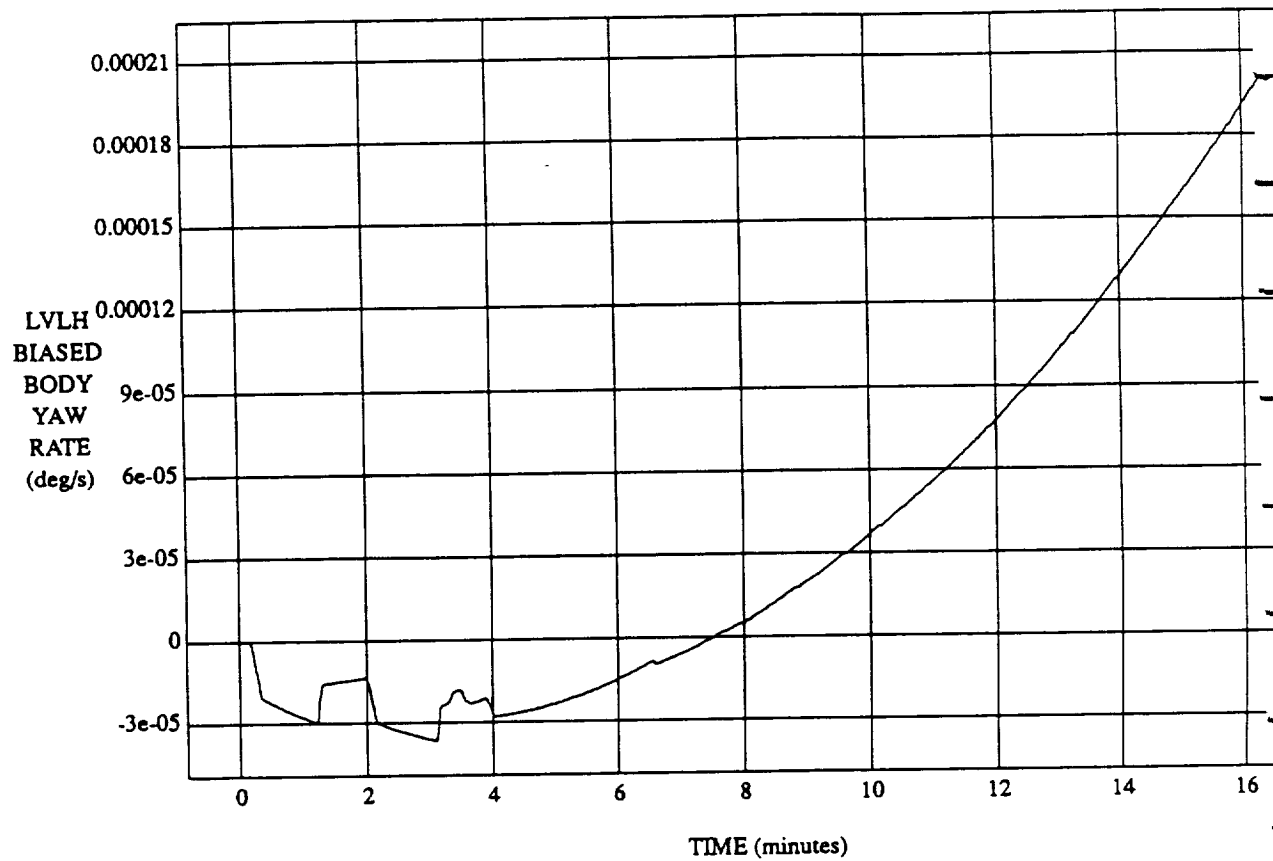
LVLH BIASED BODY PITCH RATE vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

# LVLH BIASED BODY YAW RATE vs TIME

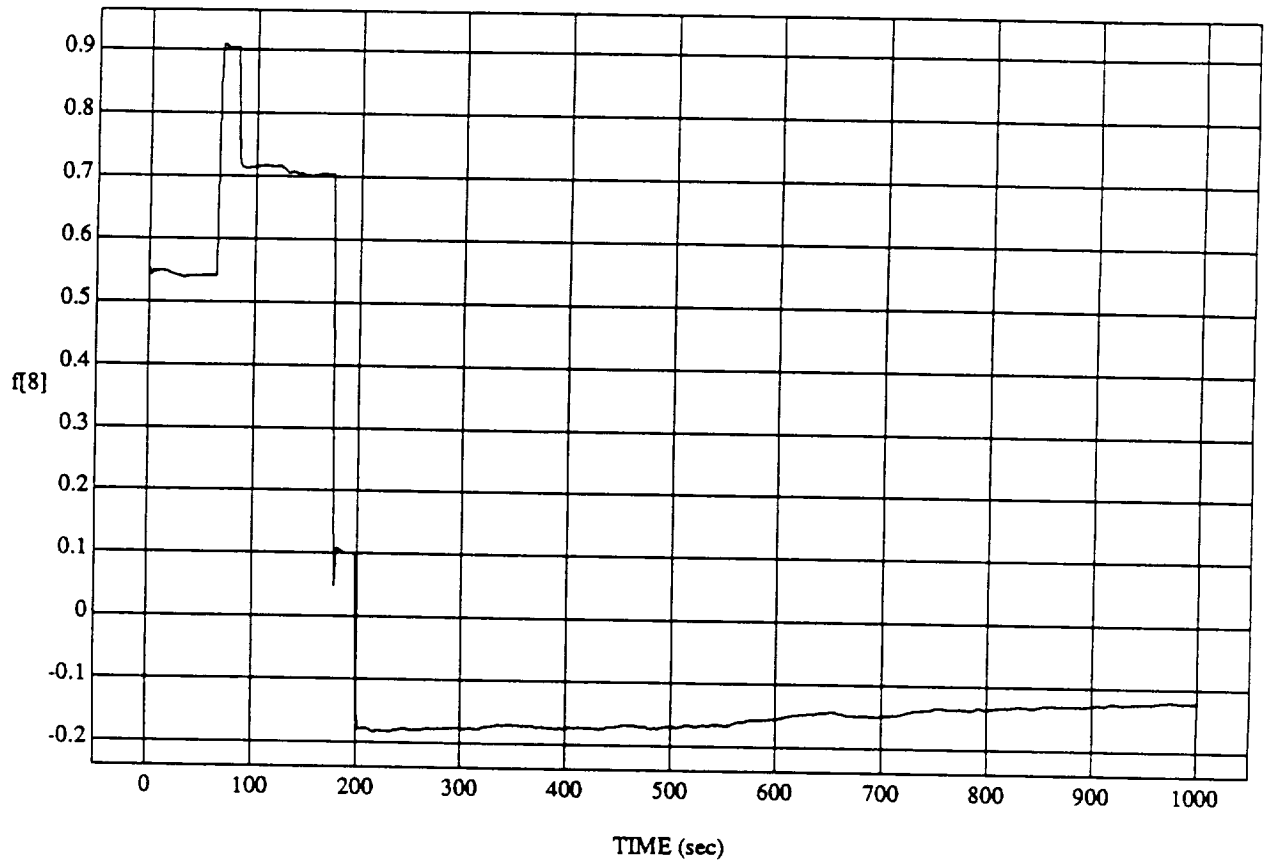
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[8]$  vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

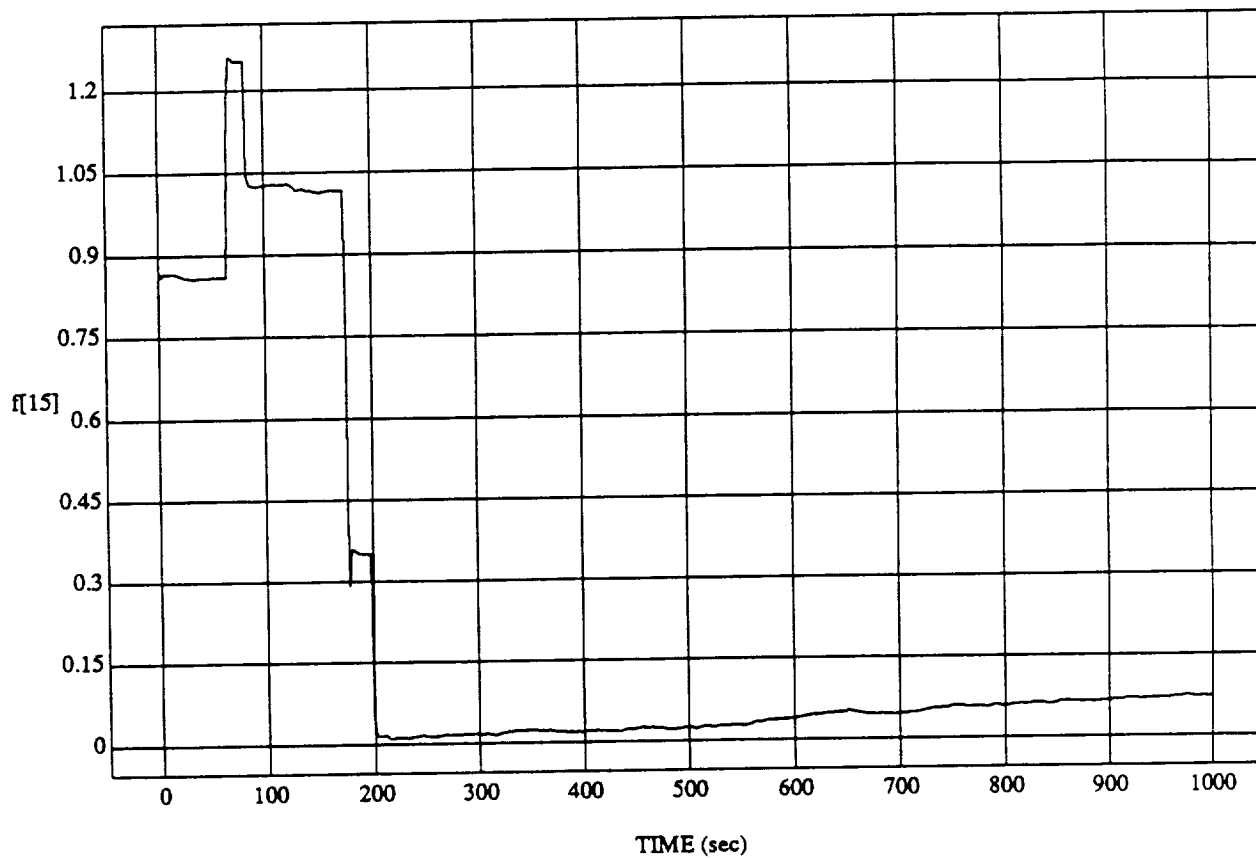


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[15] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

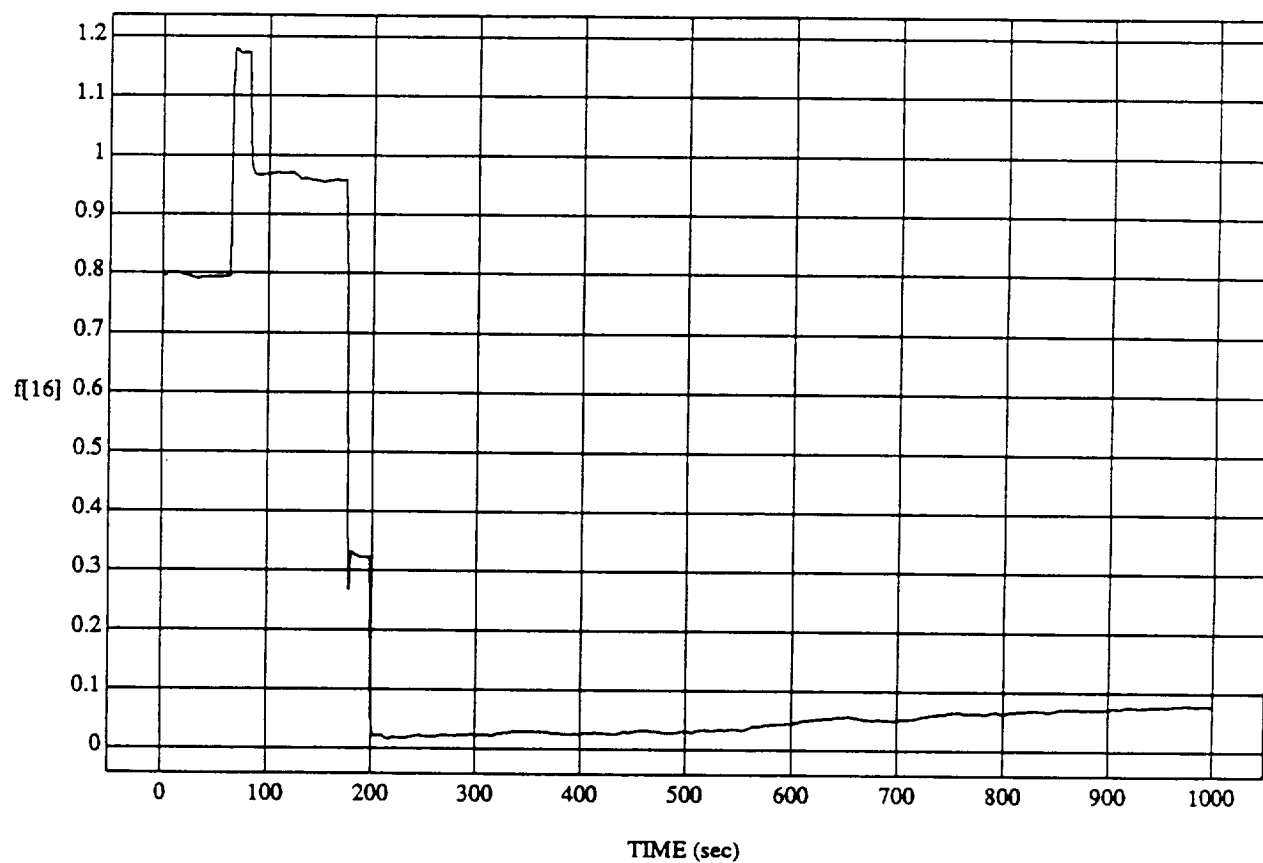


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[16] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

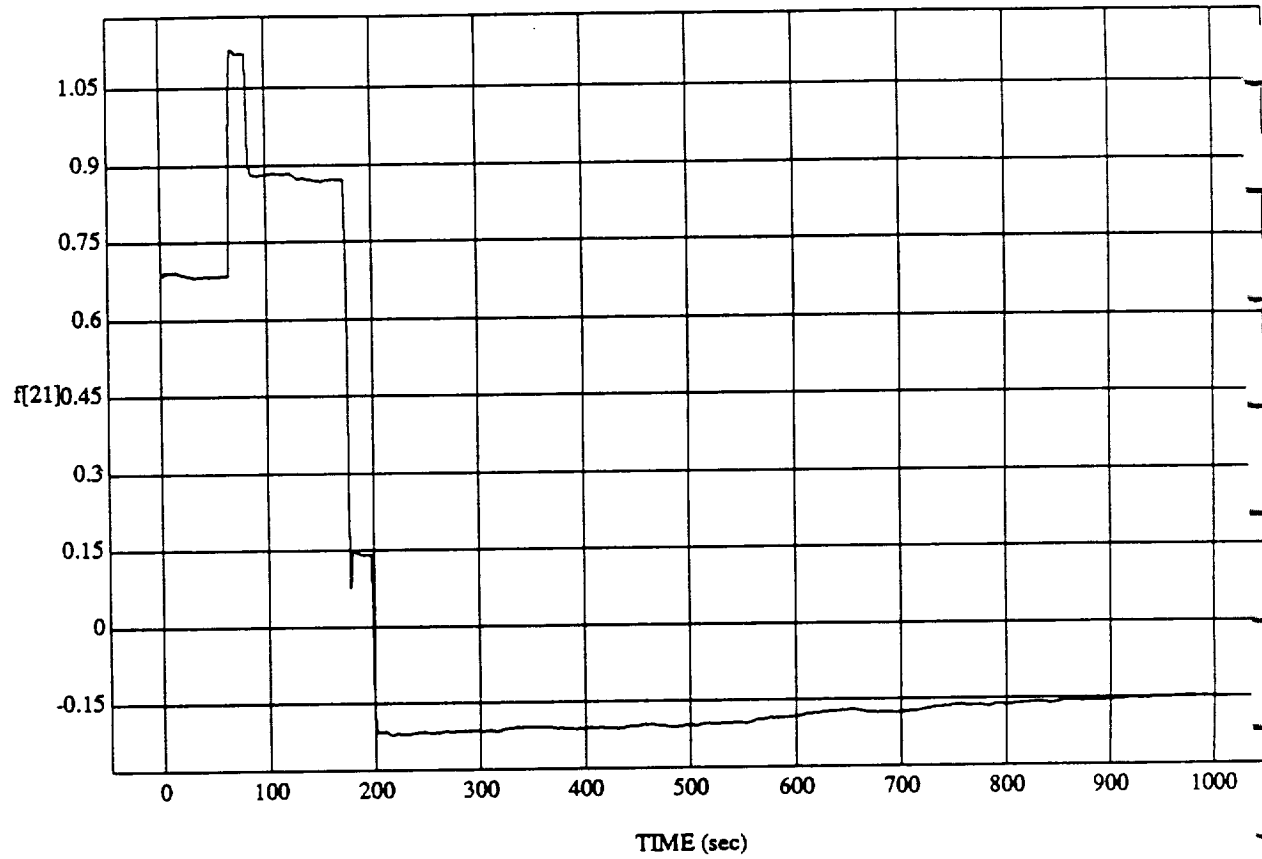


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[21] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



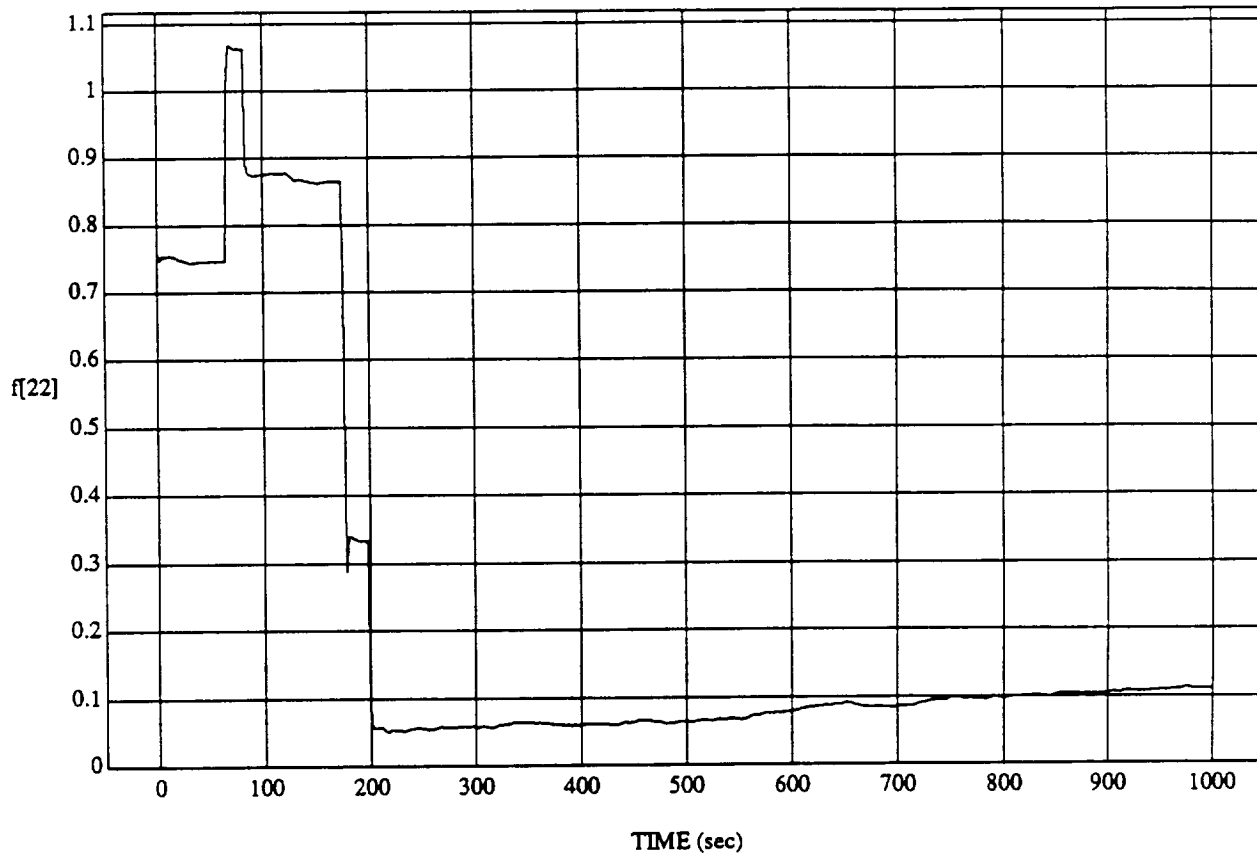
MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[22] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

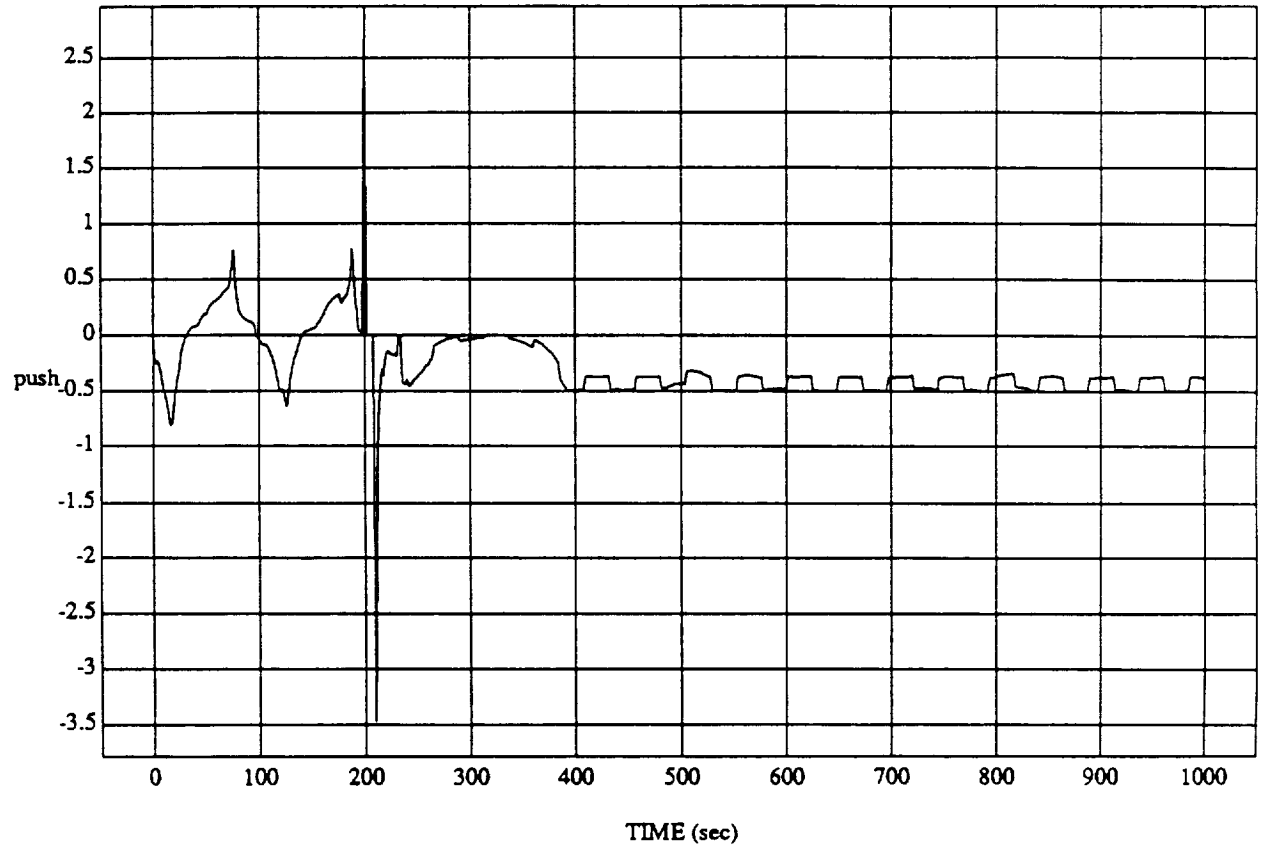


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

push vs TIME

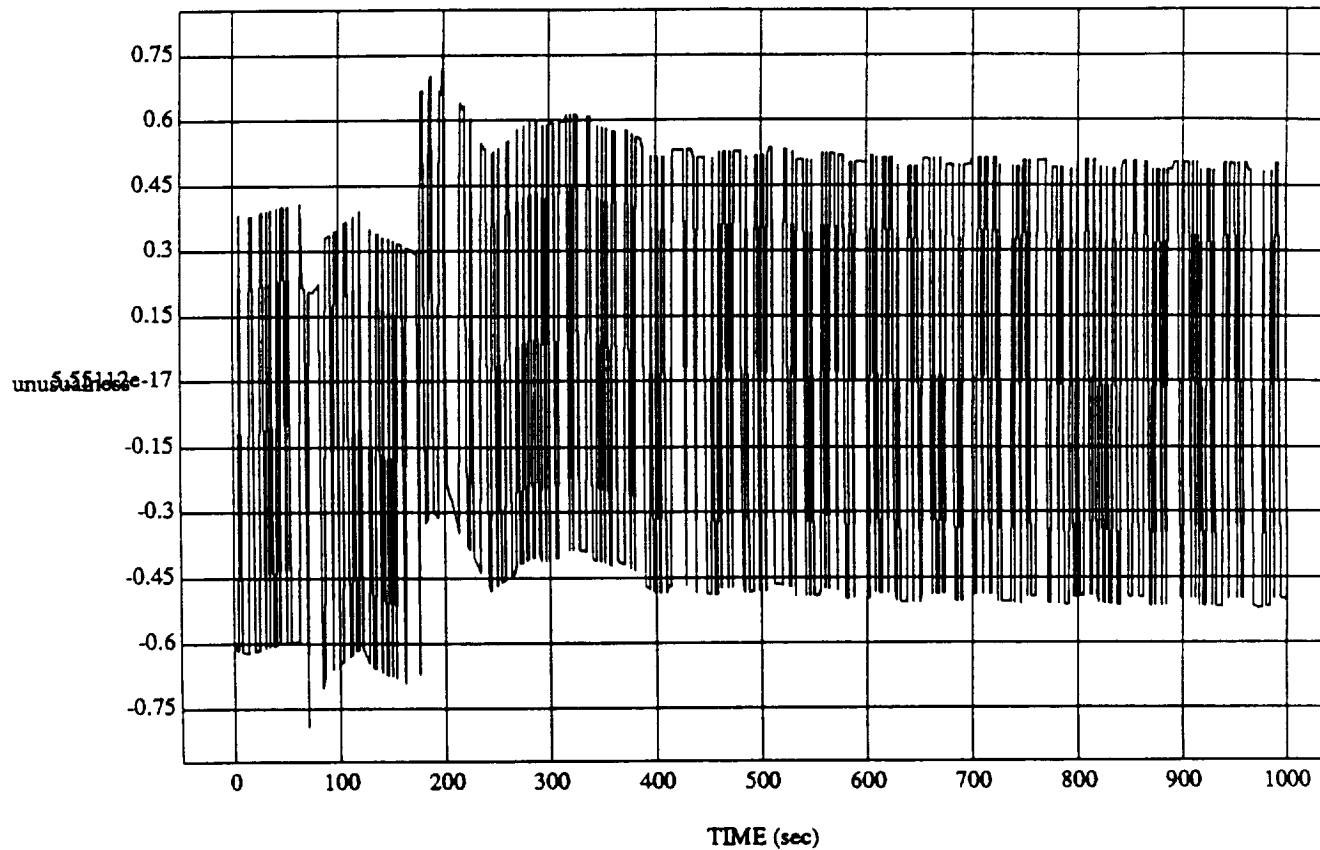
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

unusualness vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

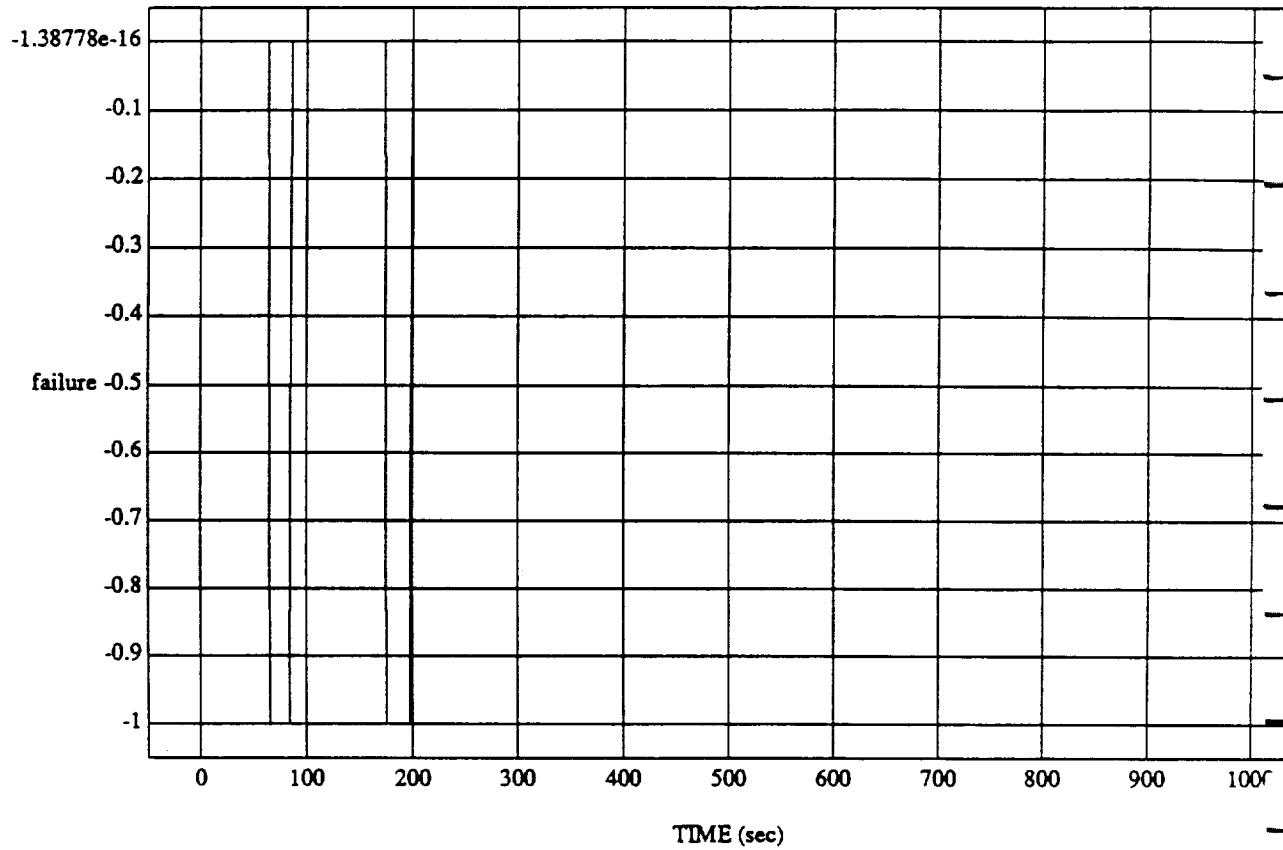


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

failure vs TIME

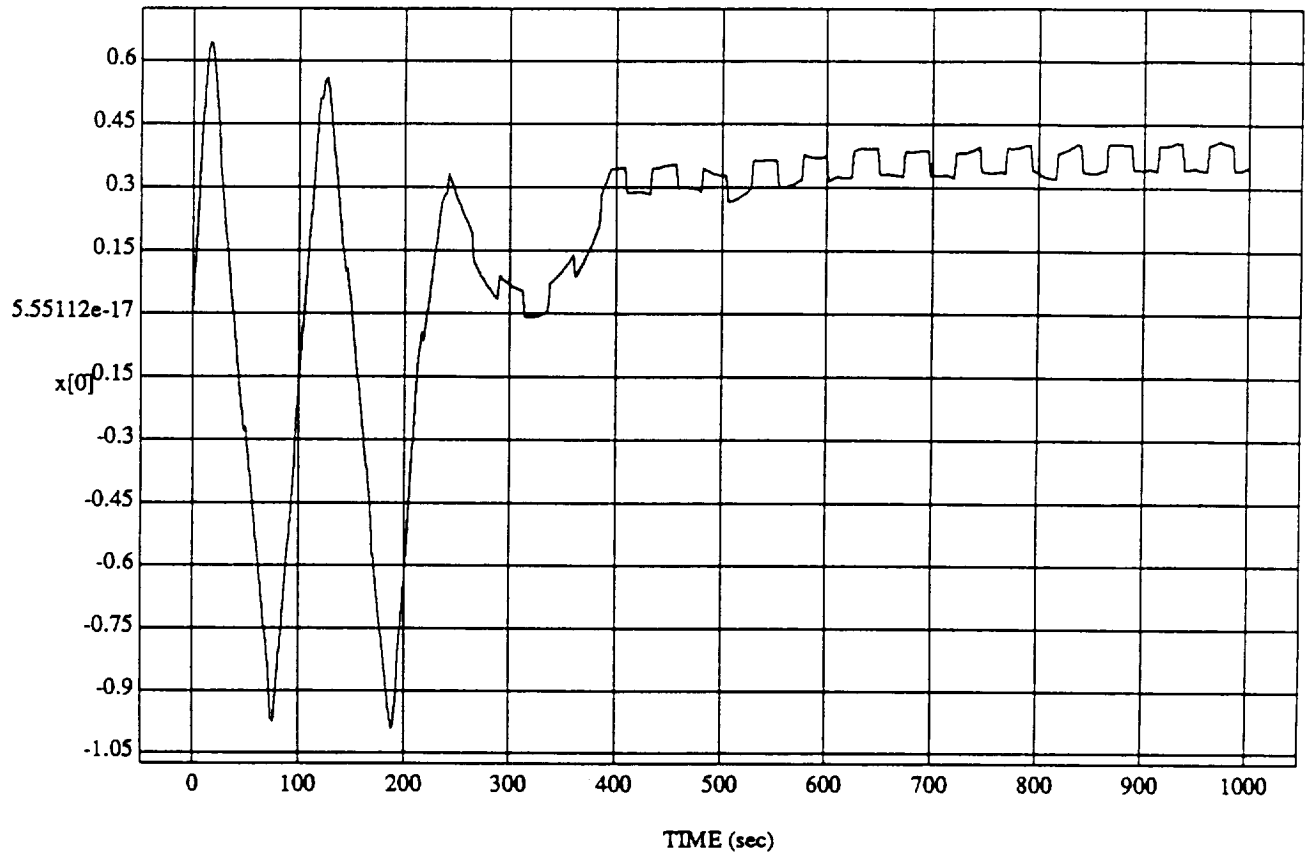
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

x[0] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

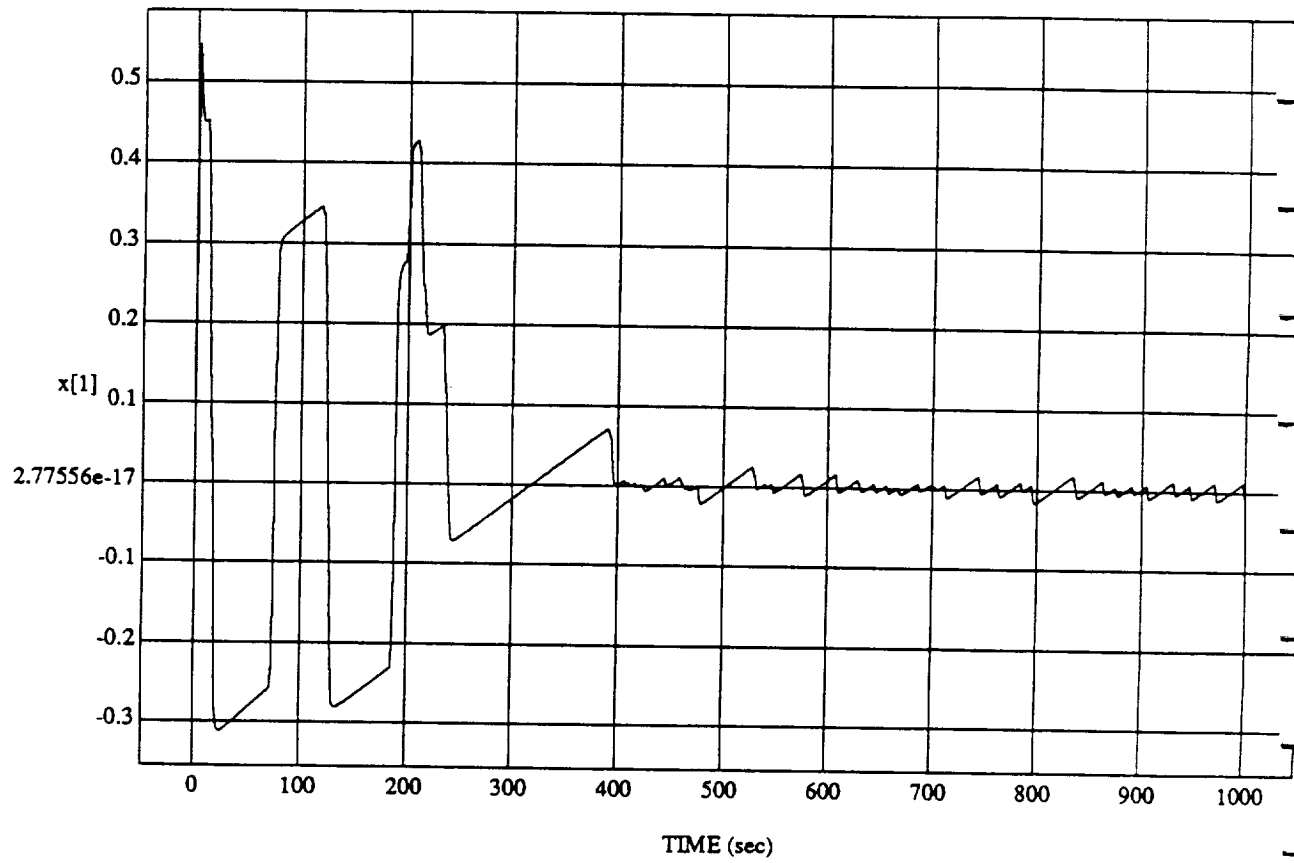


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$x[1]$  vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

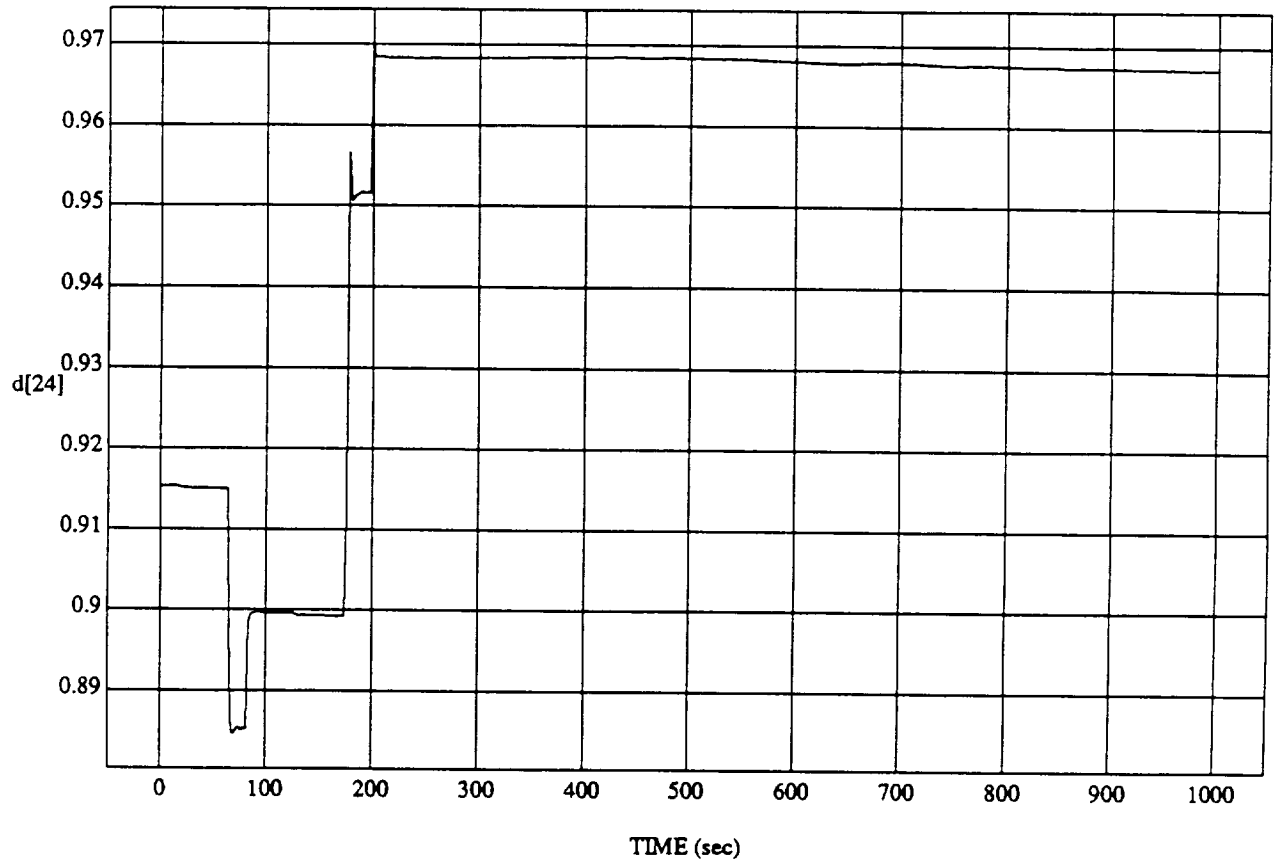


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[24] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

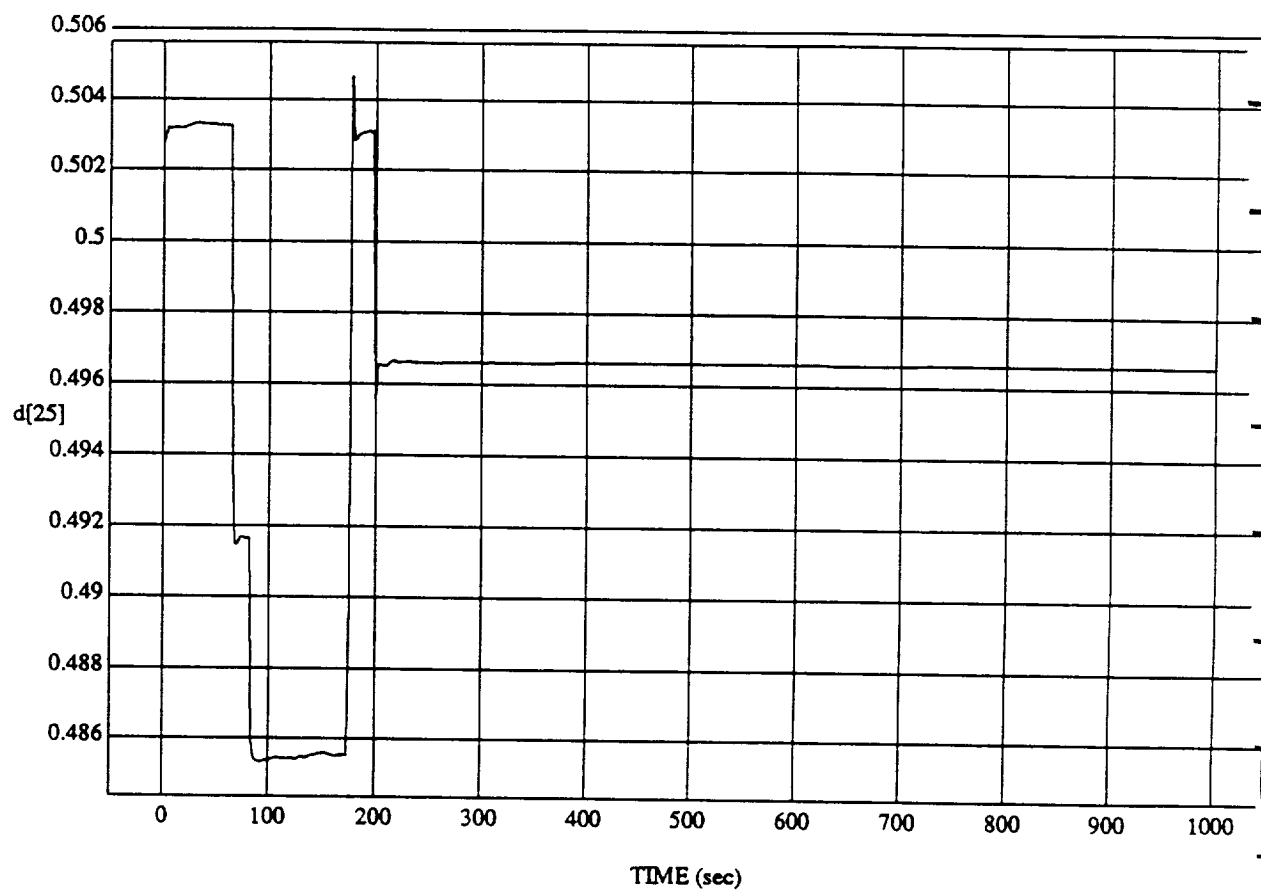


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[25] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



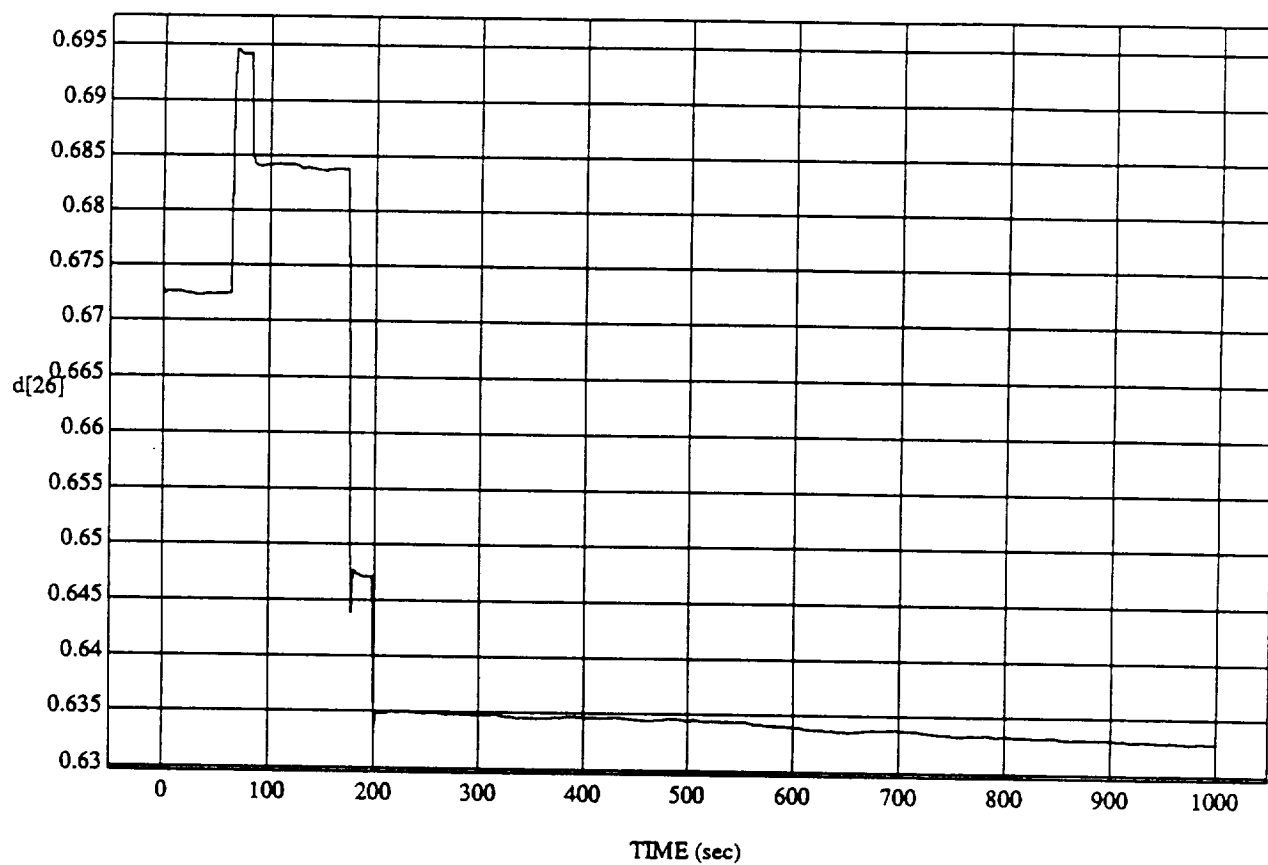
MODULE: ORB\_FUZZ\_BATCH.lean2

DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[26] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

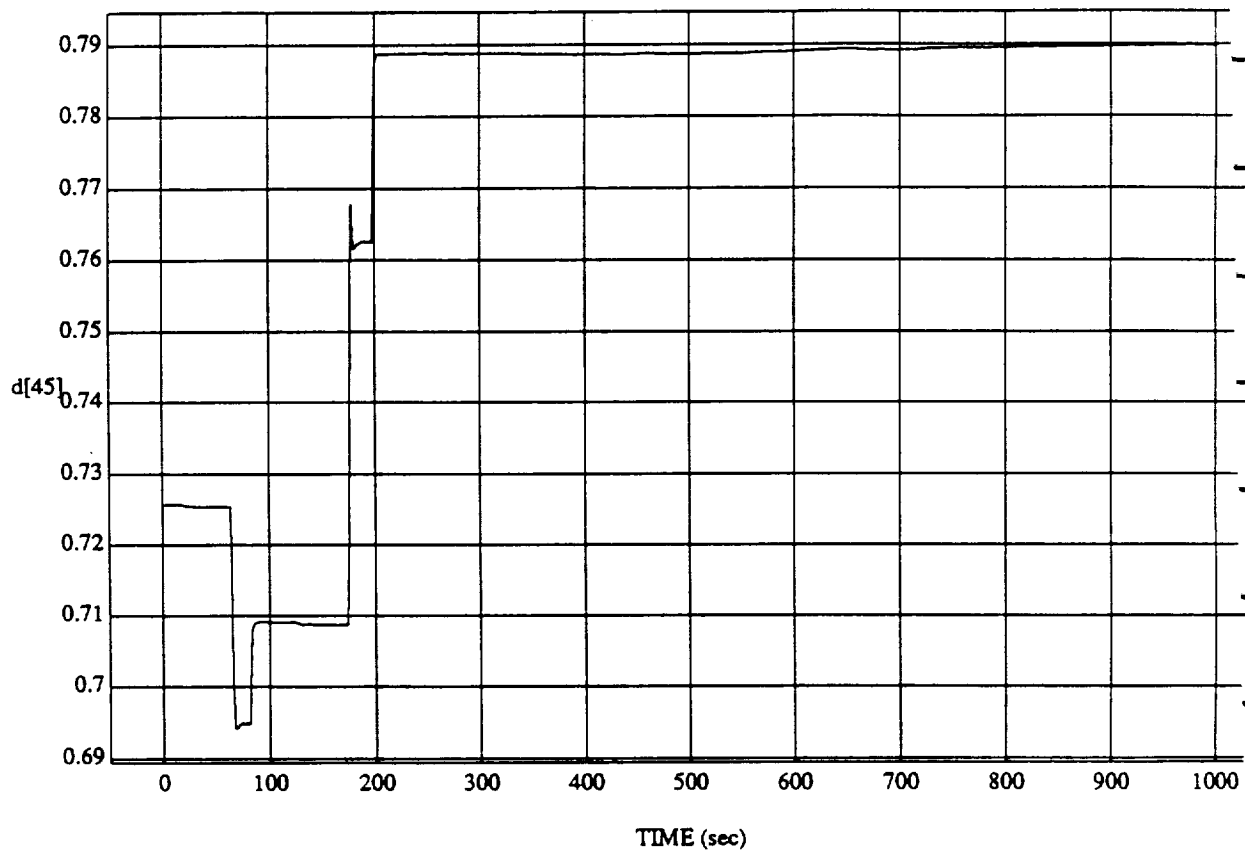


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[45] vs TIME

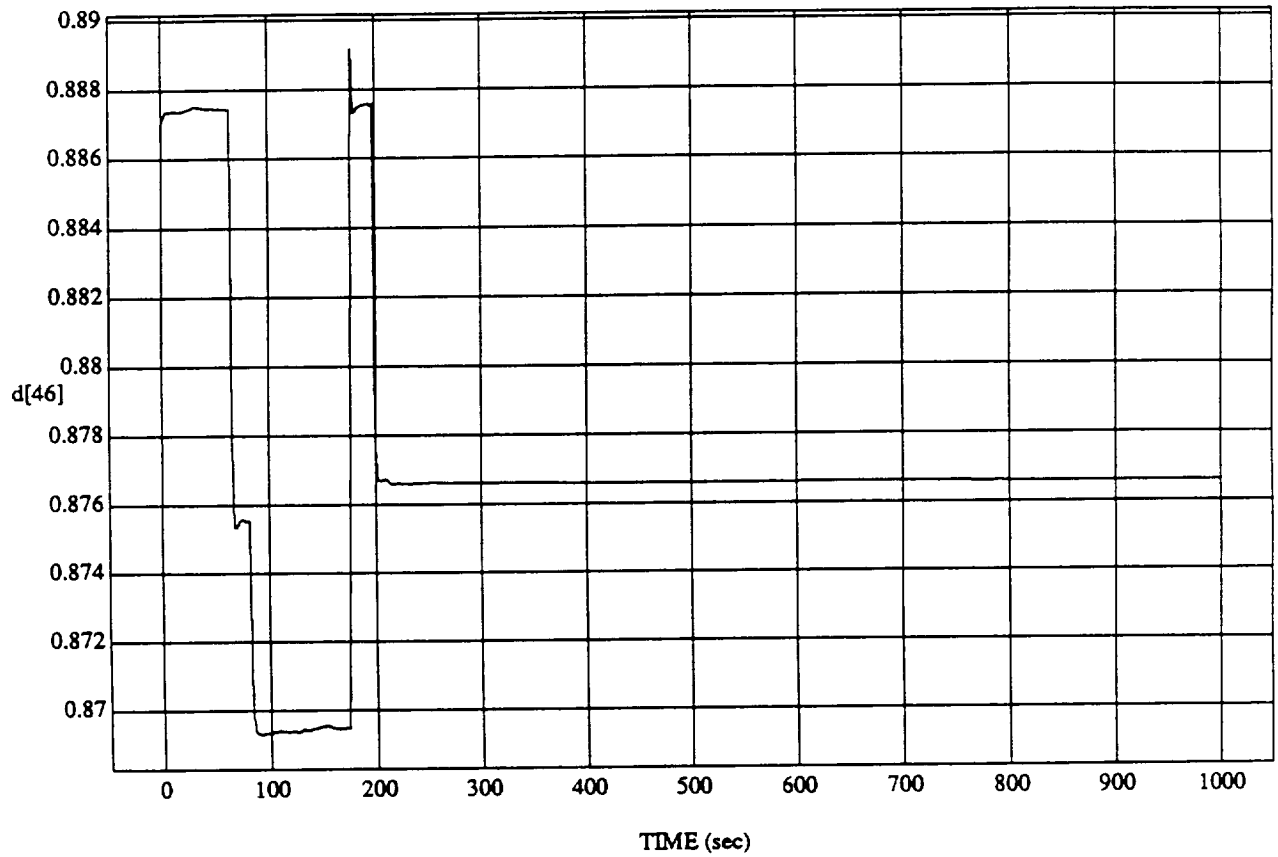
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

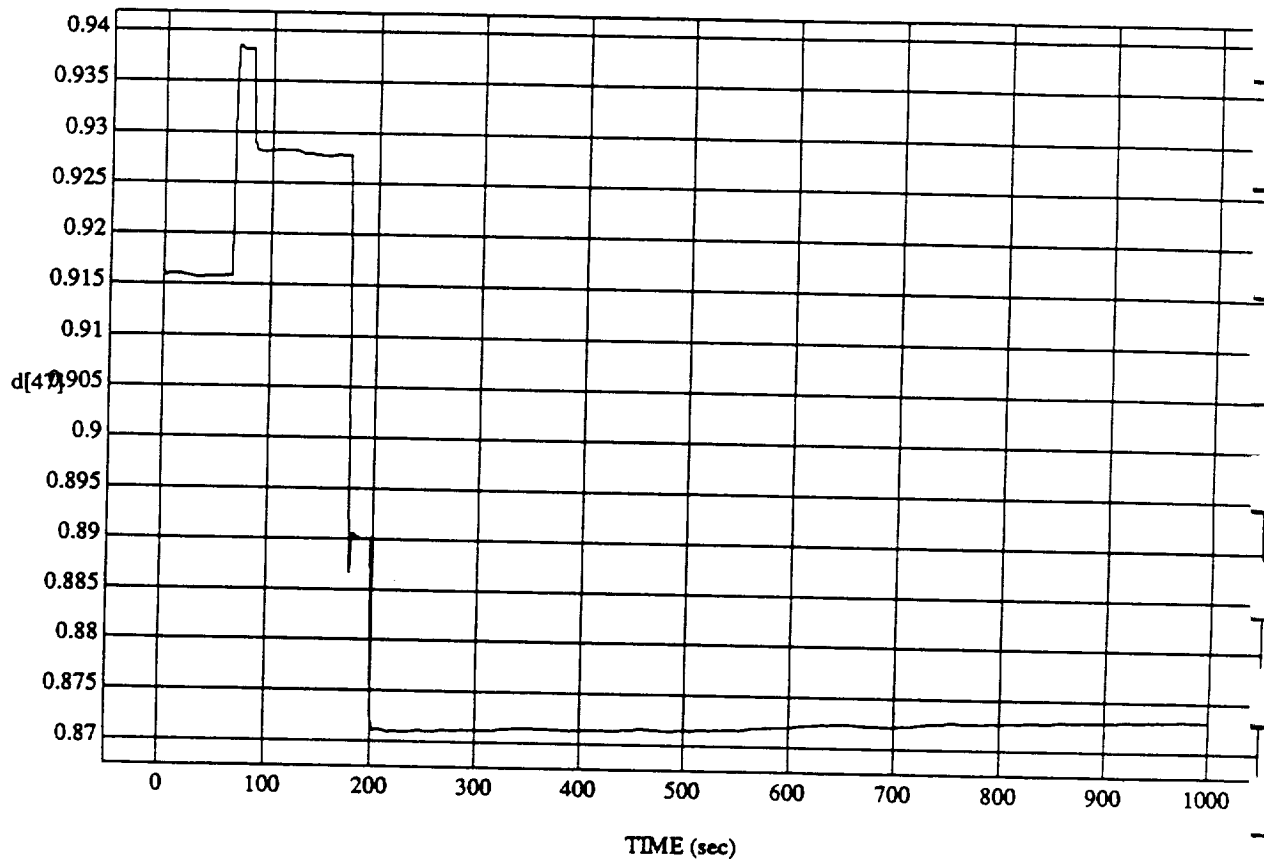
d[46] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

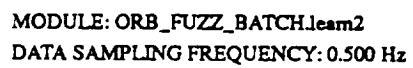
SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[47] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

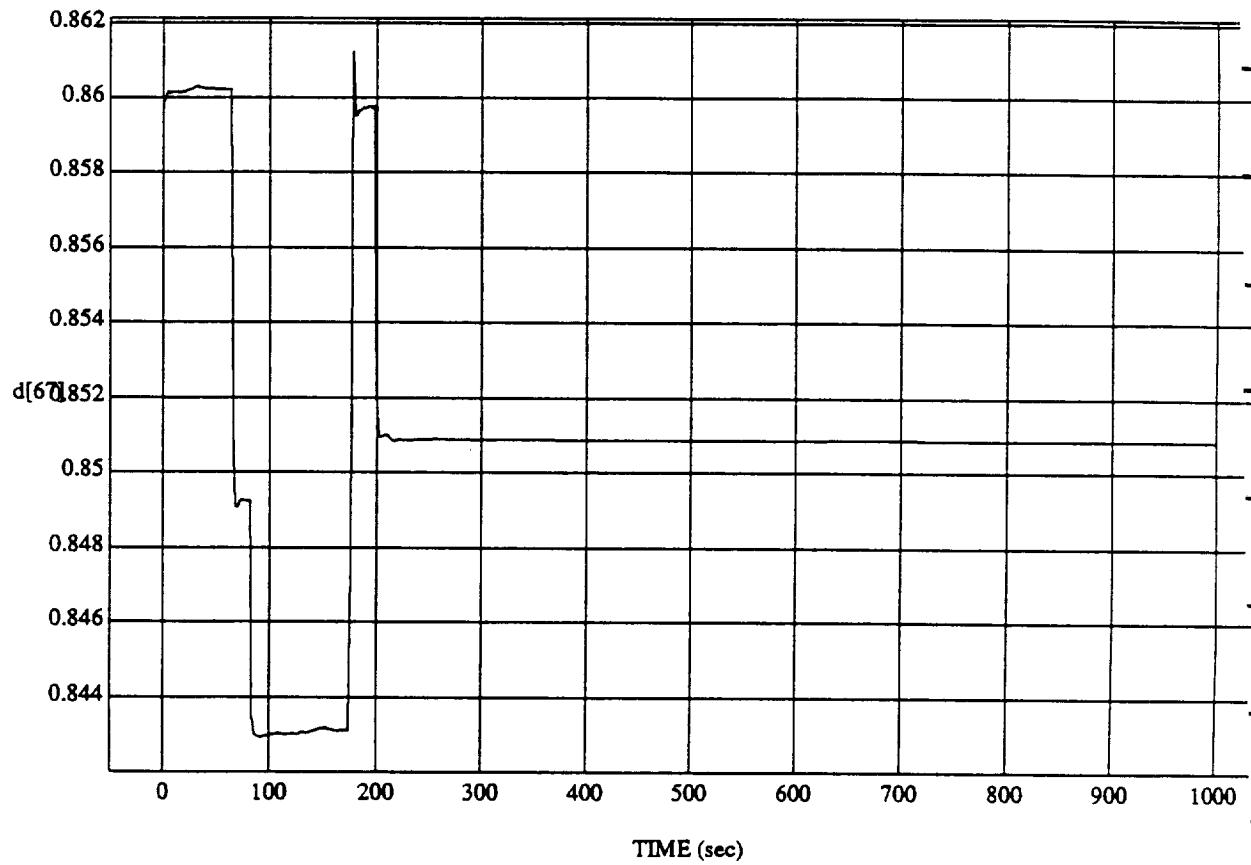
d[66] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[67] vs TIME

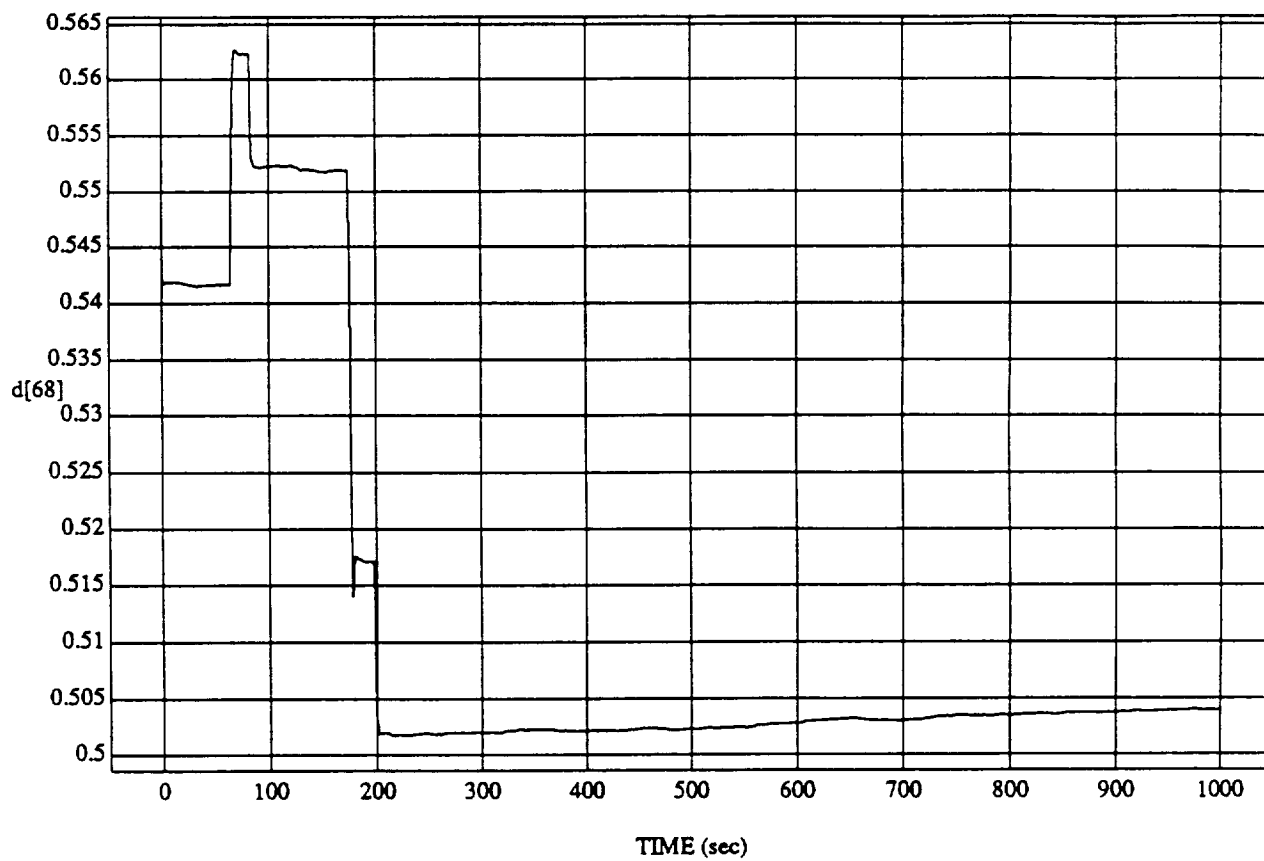
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

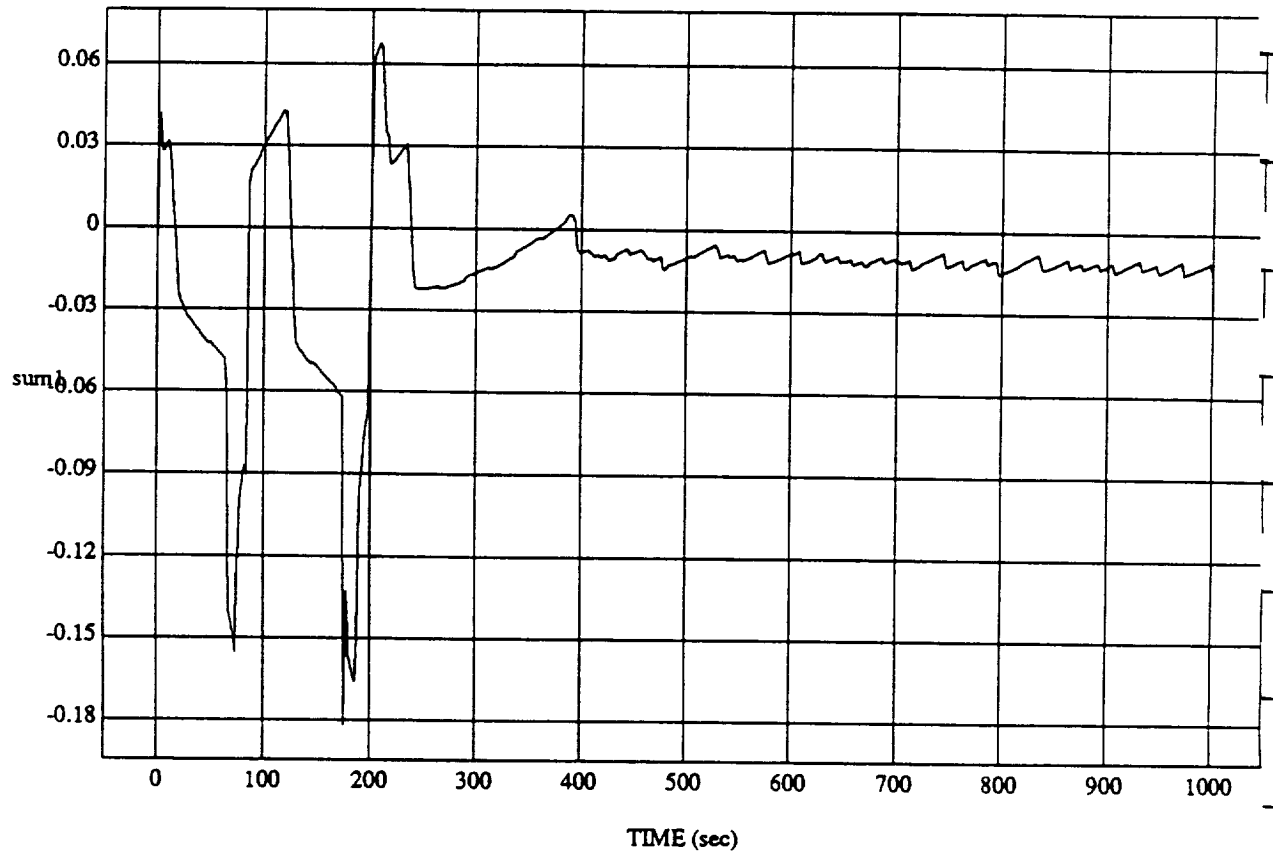
d[68] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sum1 vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

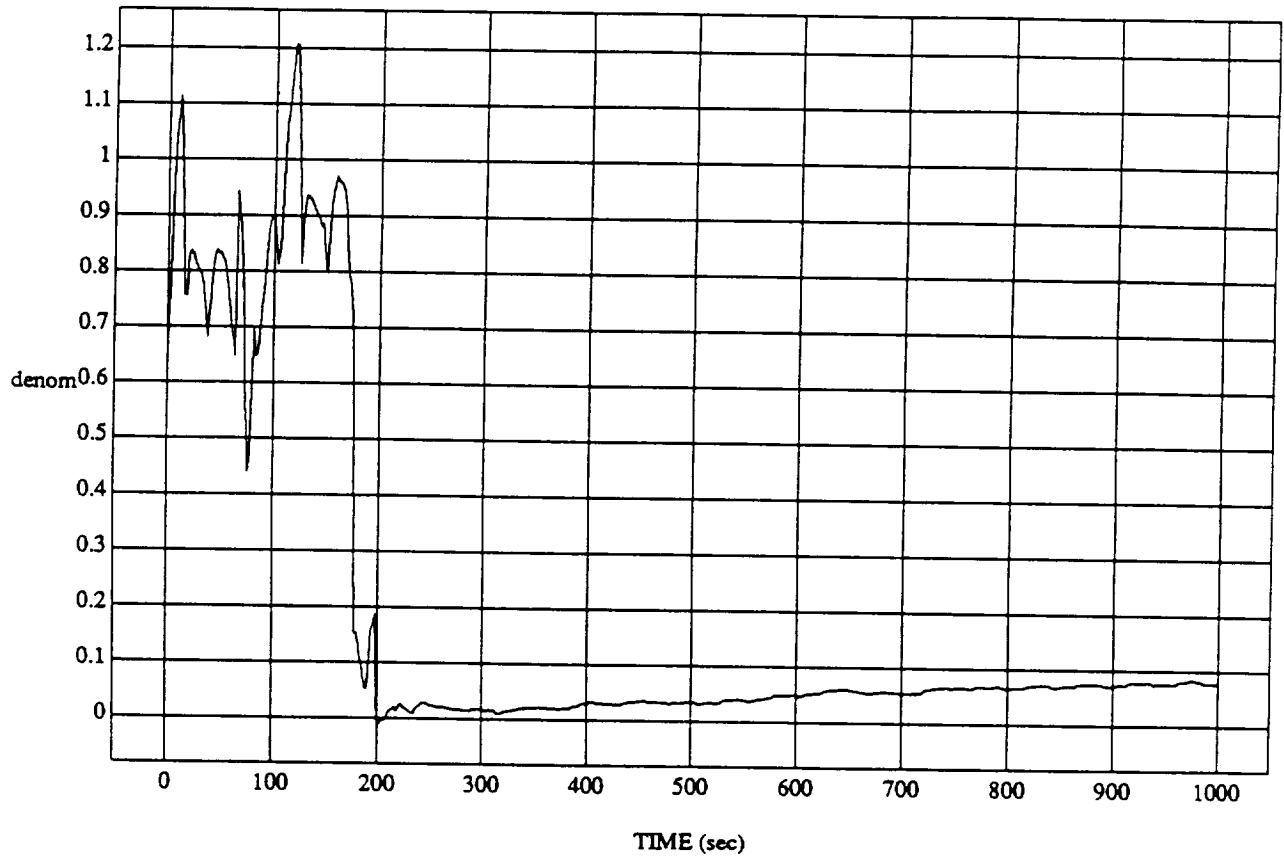


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

denom vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz







V

D&F  
 $.9 \pm \text{kind}(0.1)$

+

if / 1050 \* L → learn

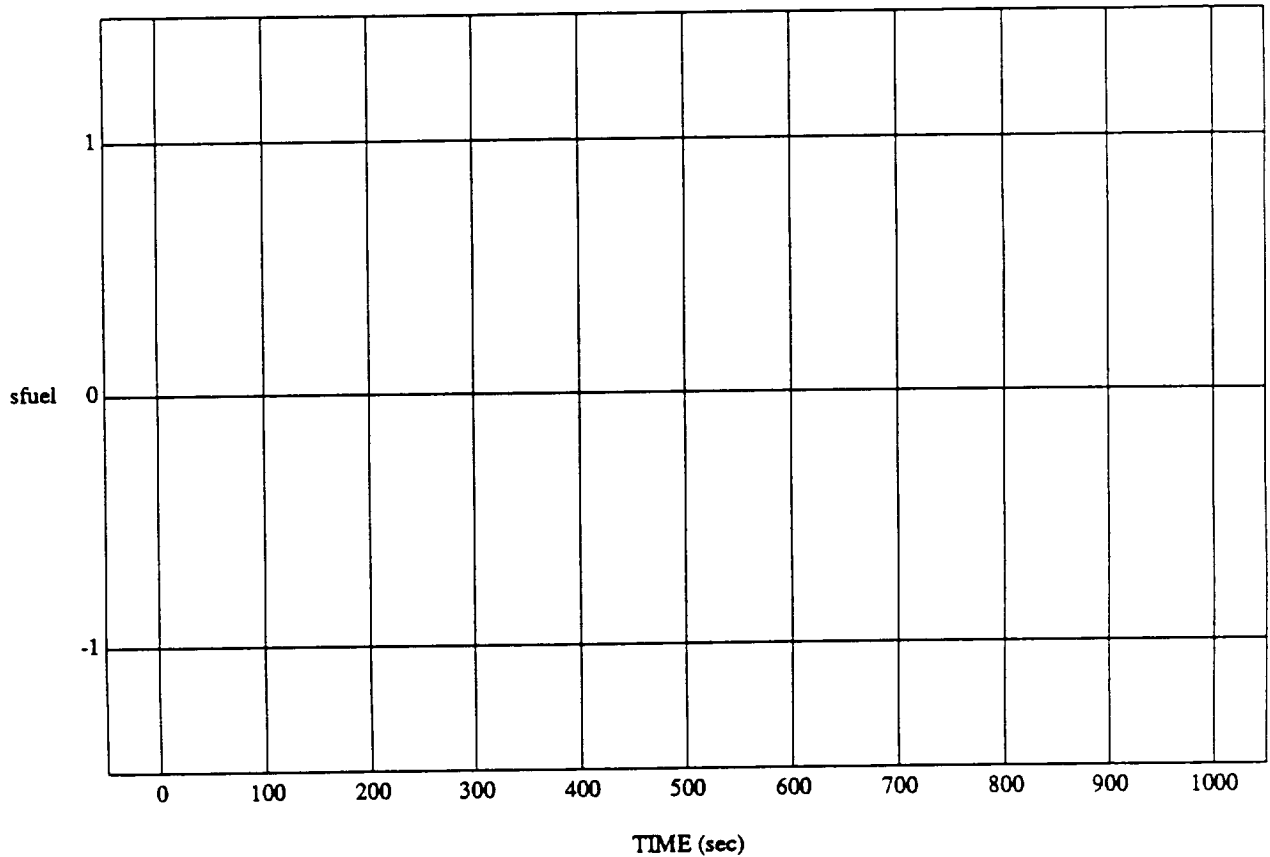
< / L → su. 1

1 L → push = 0.6 }

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME

RUN: Fuzzy / NN Learner ~ Rnd D's & Norm SUM3 - 4 May 1992

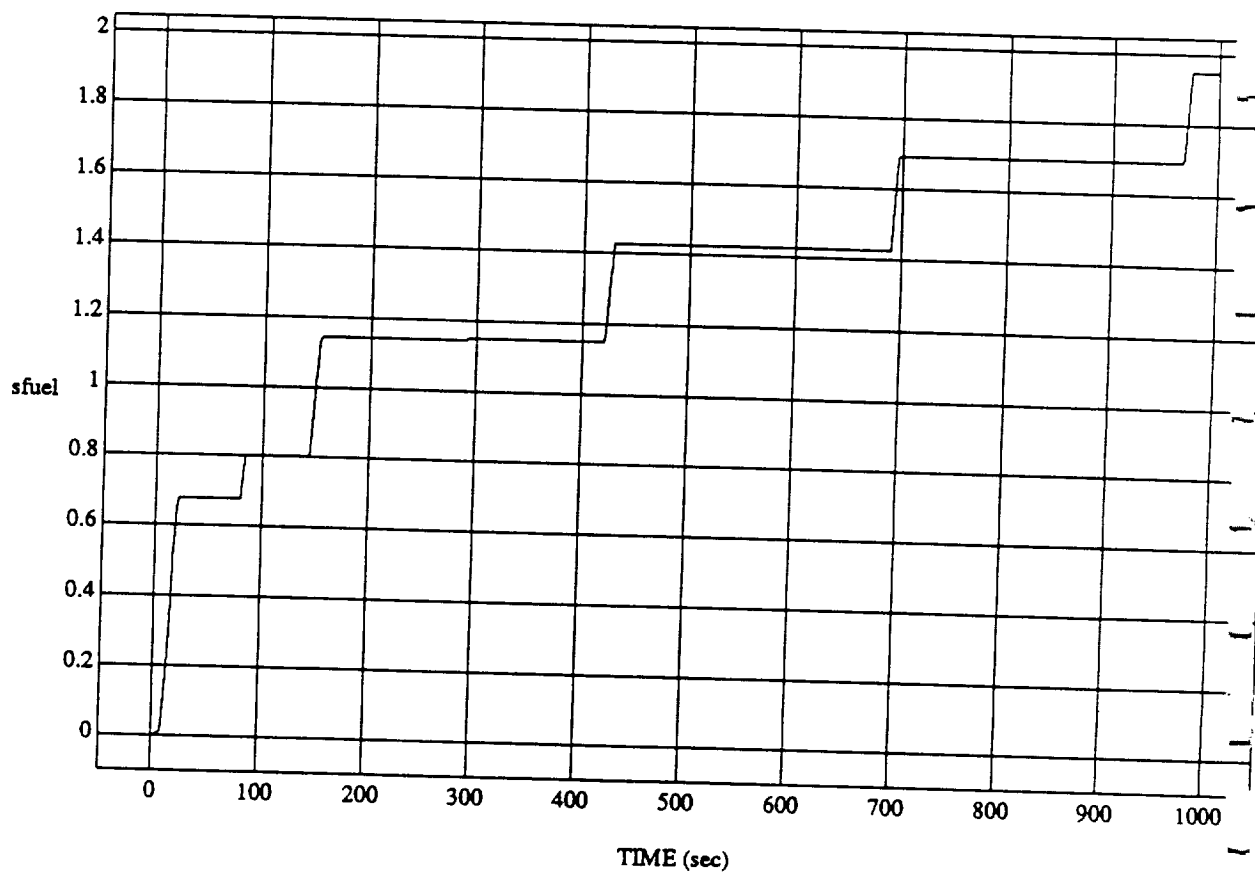


MODULE: ORB\_FUZZ\_BATCH.primary  
 DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME

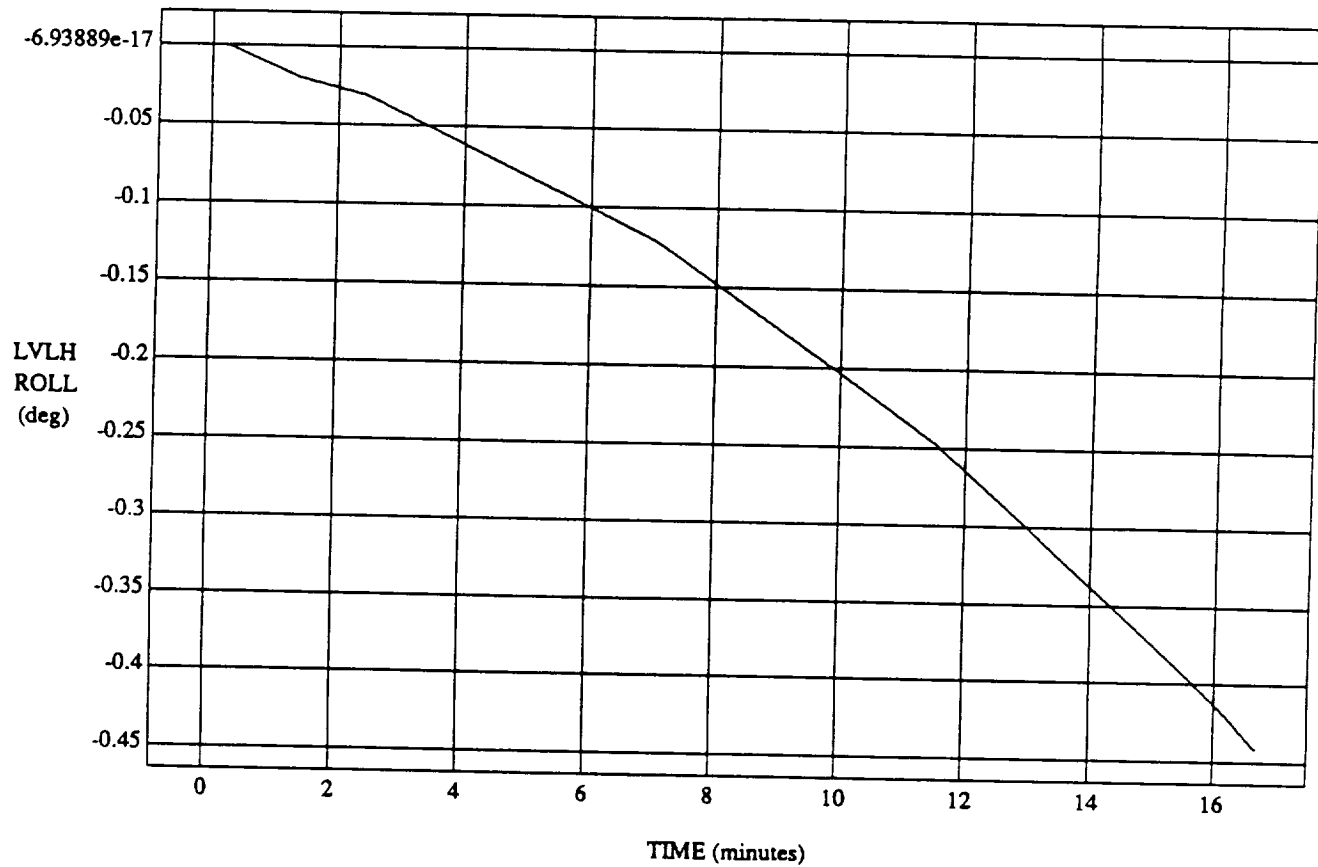
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

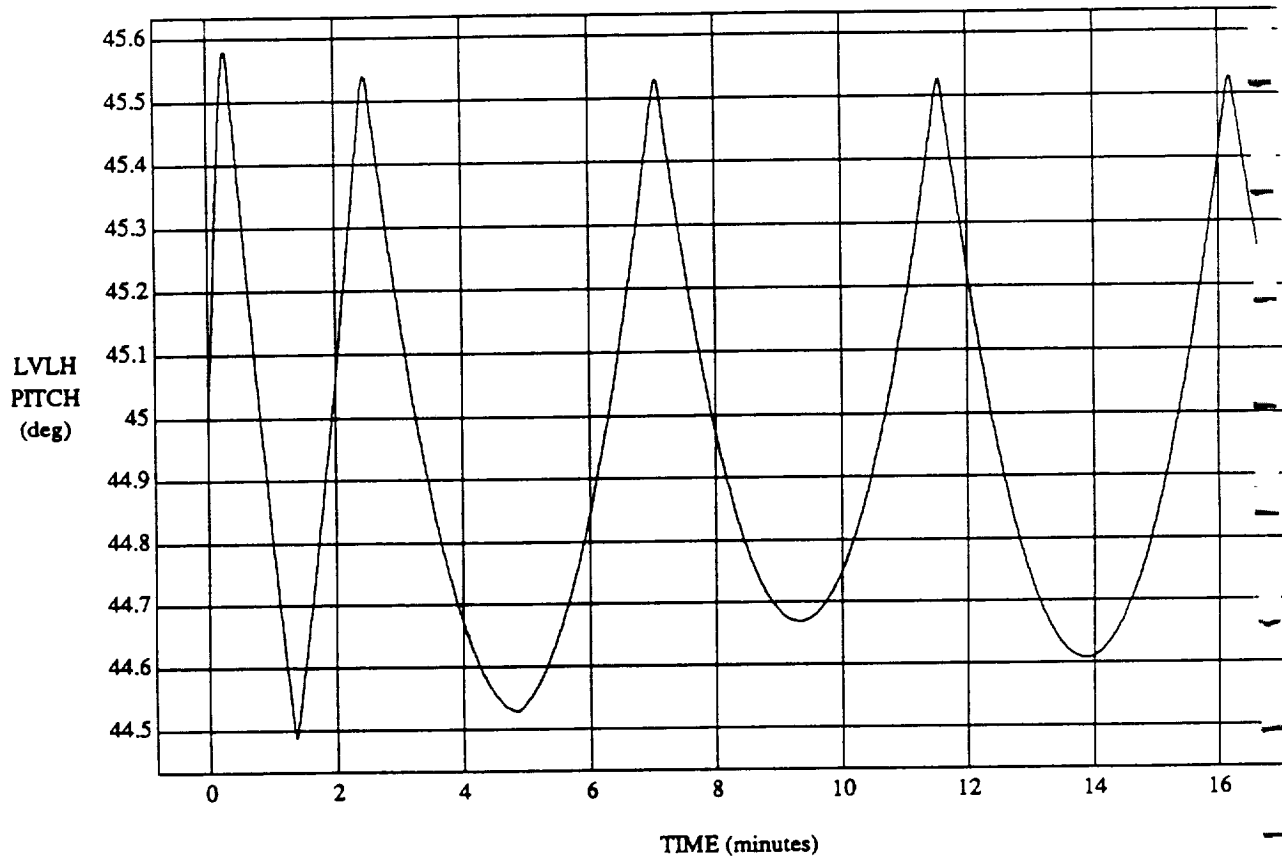
LVLH EULER PYR ROLL vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH EULER PYR PITCH vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

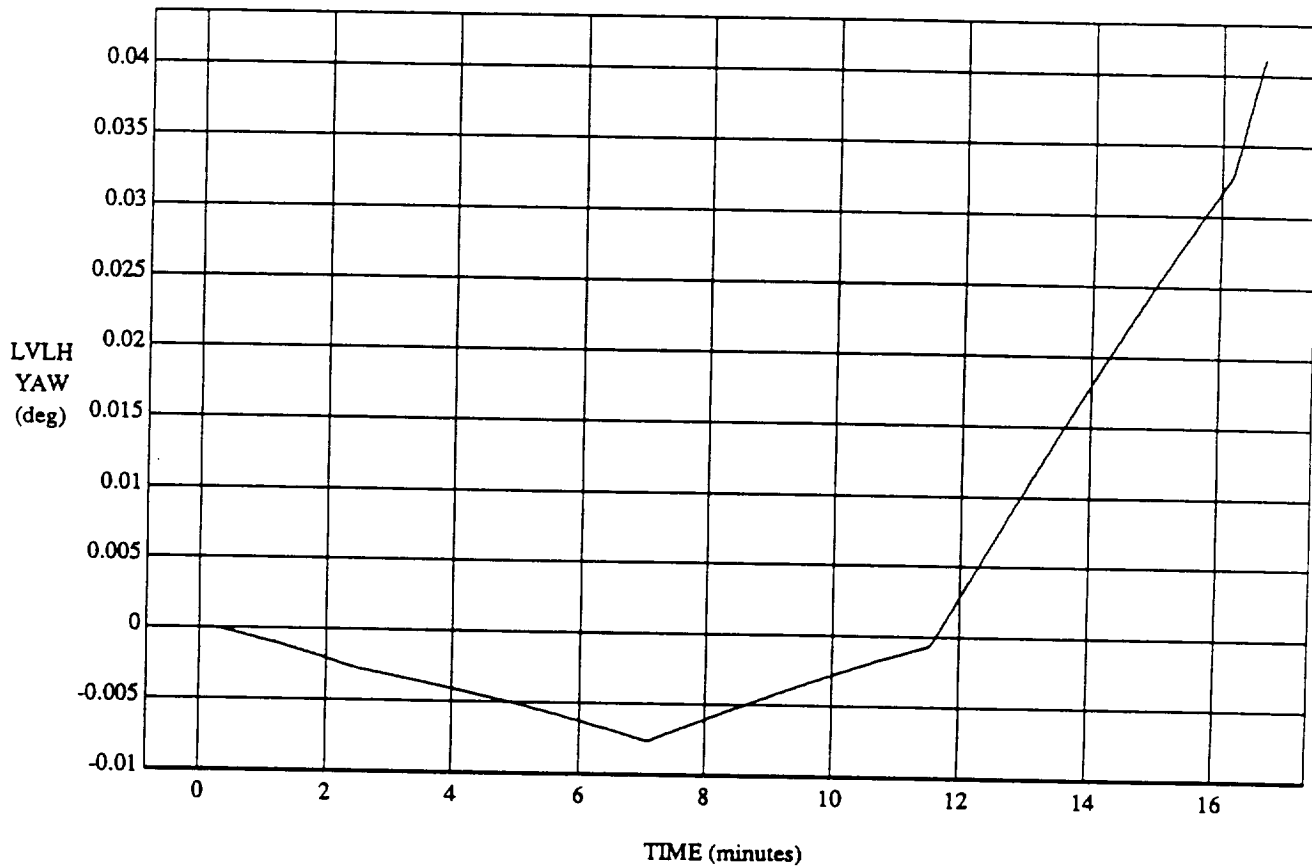


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

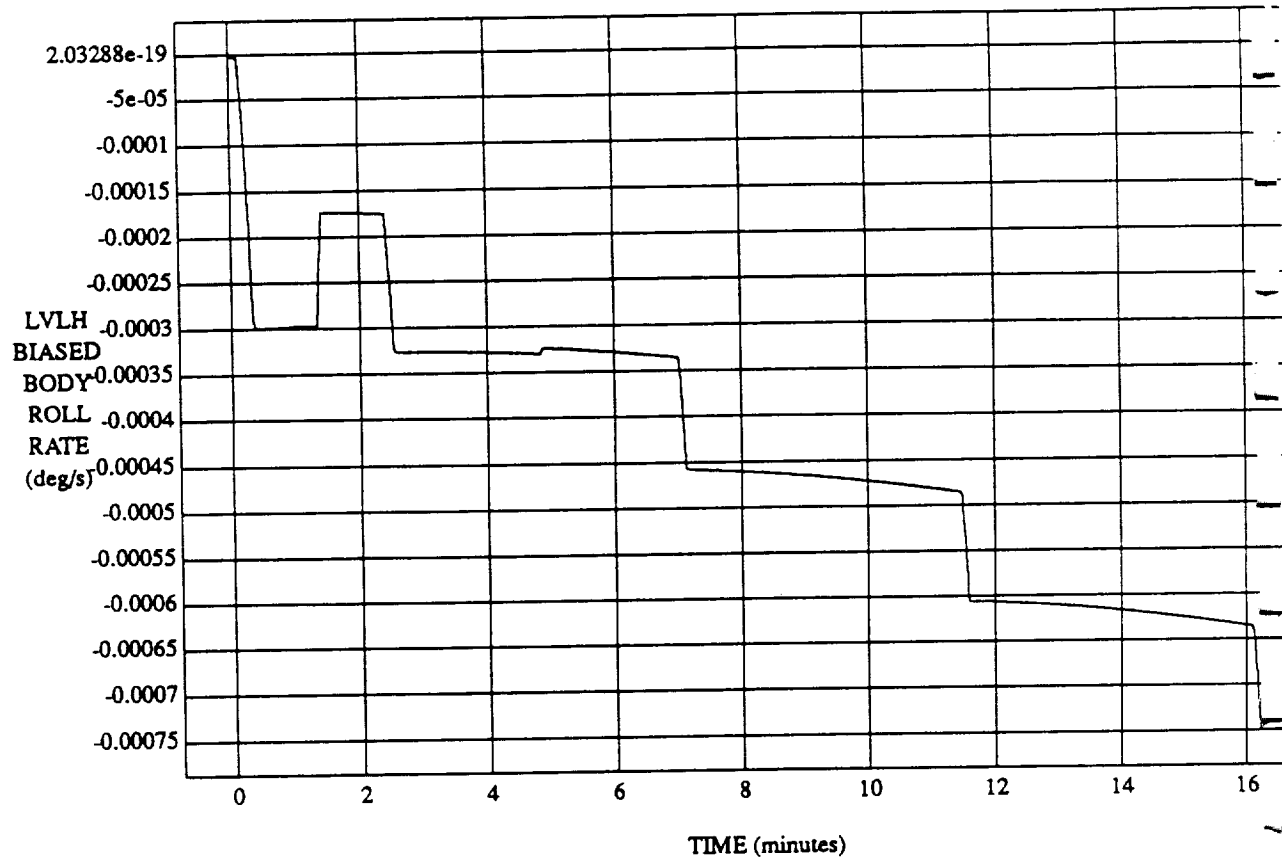
**LVLH EULER PYR YAW vs TIME**  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH BIASED BODY ROLL RATE vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

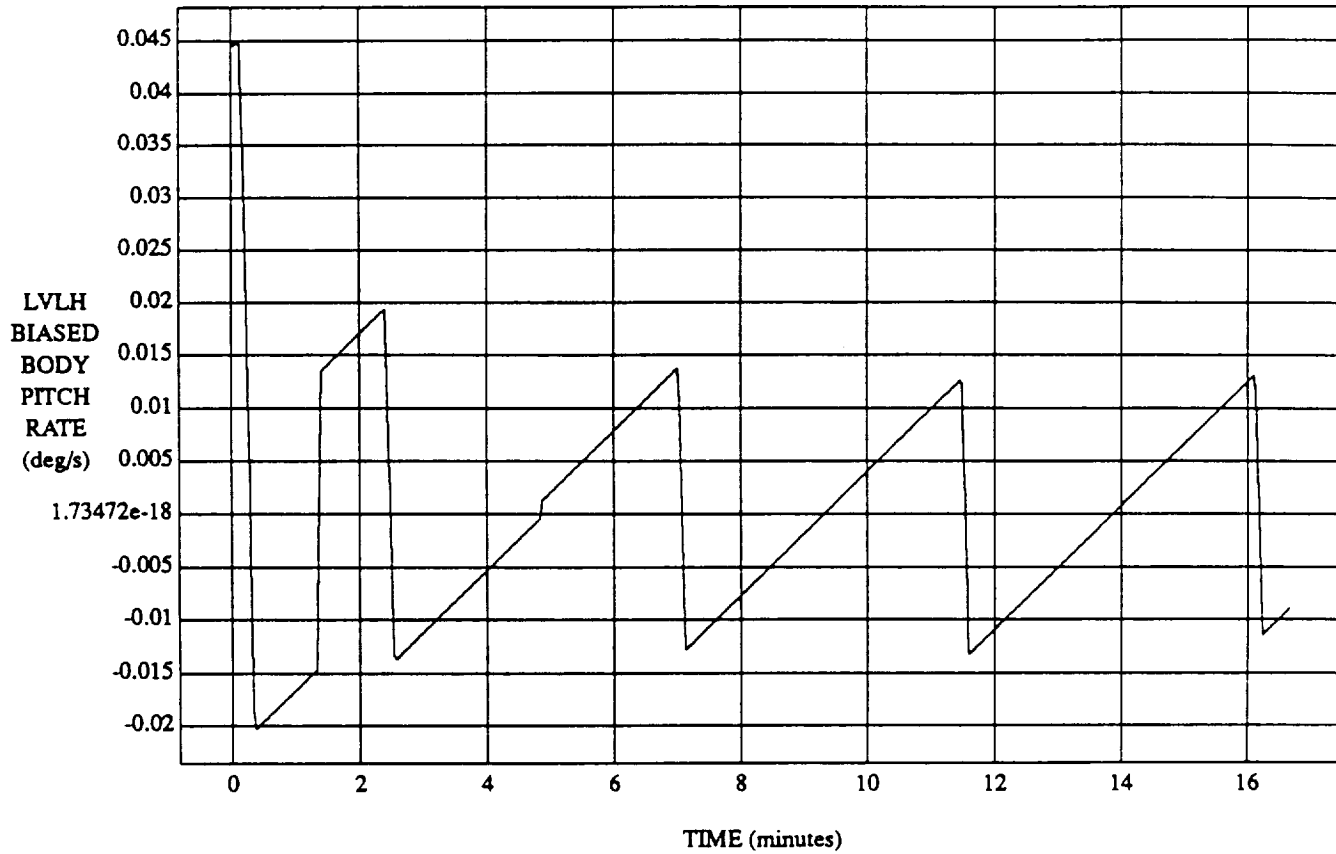


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH BIASED BODY PITCH RATE vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

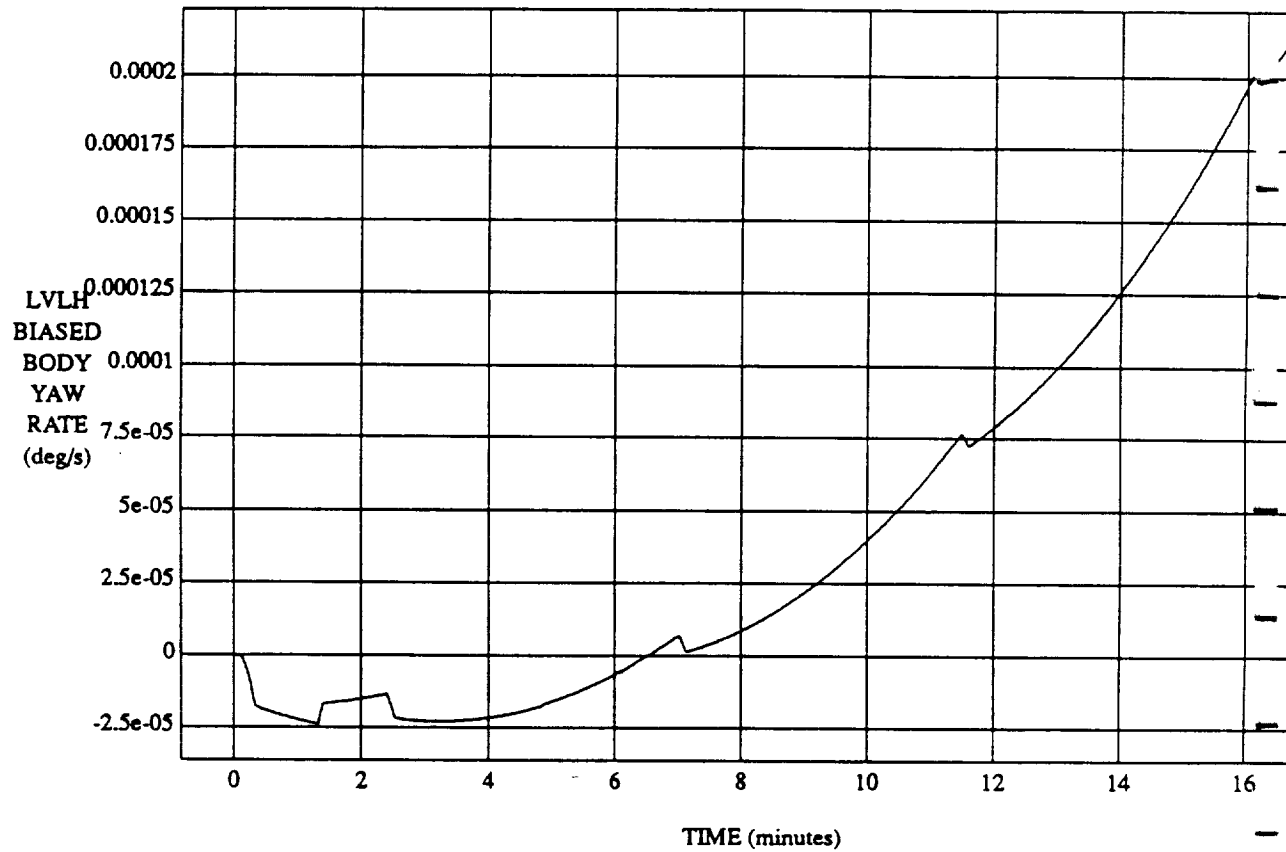


VEHICLE: ORB\_FUZZ\_BATCH.state

DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH BIASED BODY YAW RATE vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

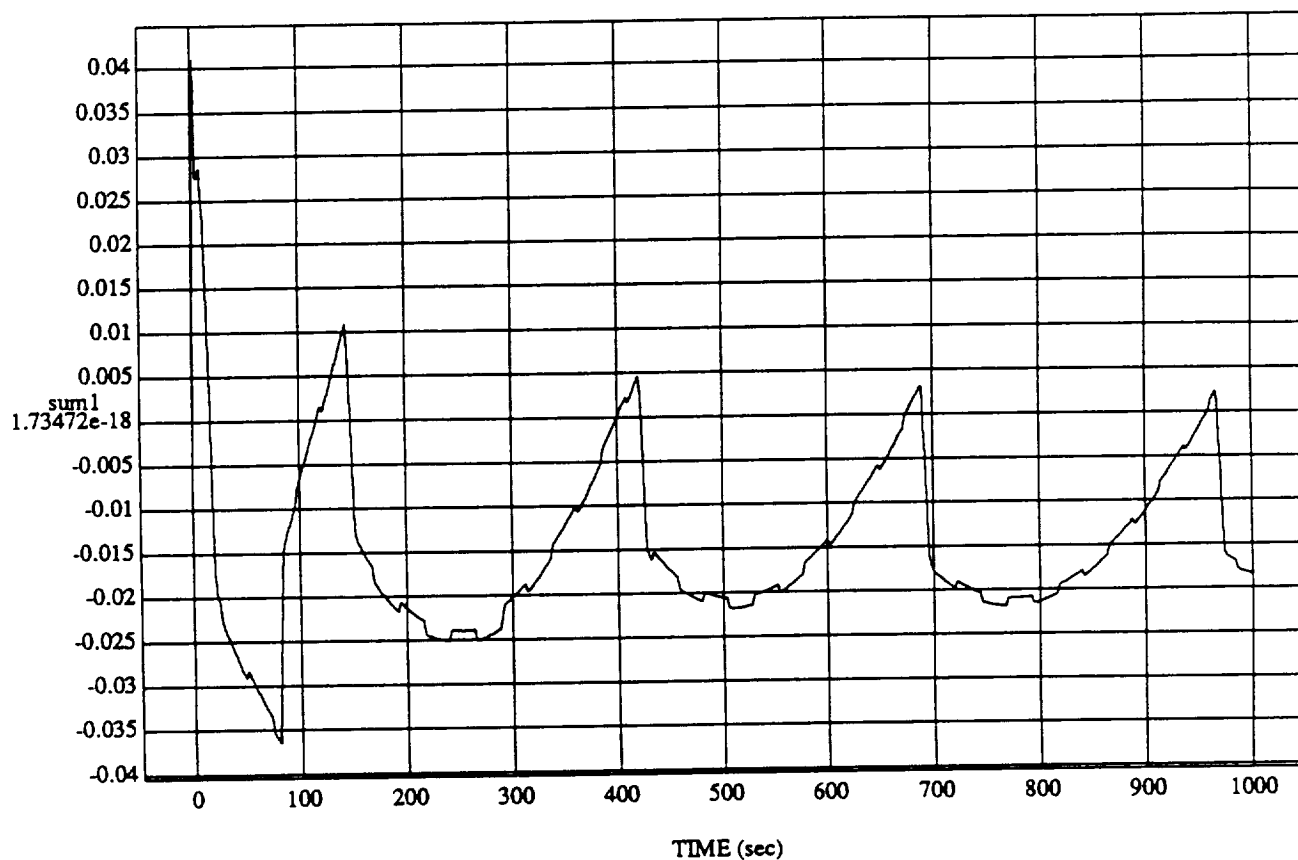


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sum1 vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

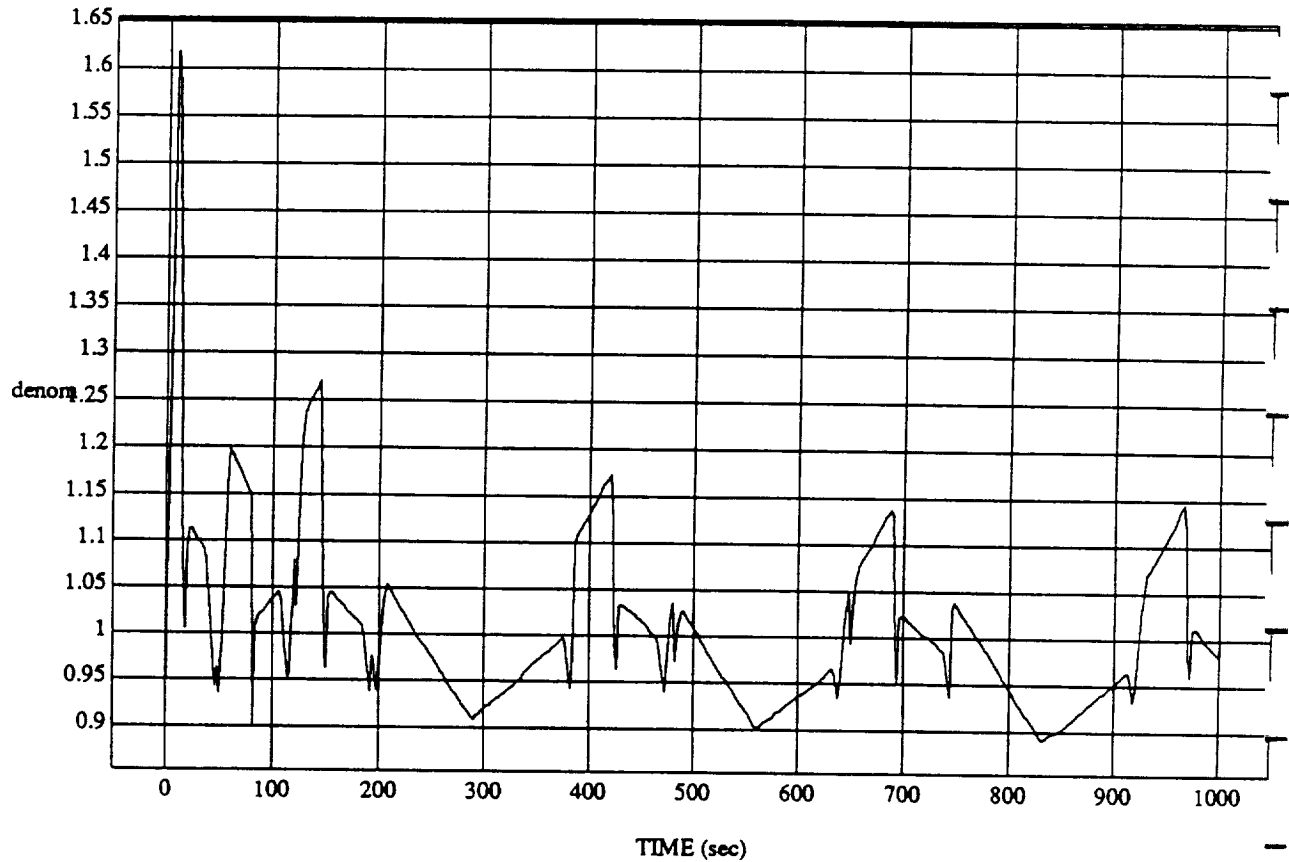


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

denom vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

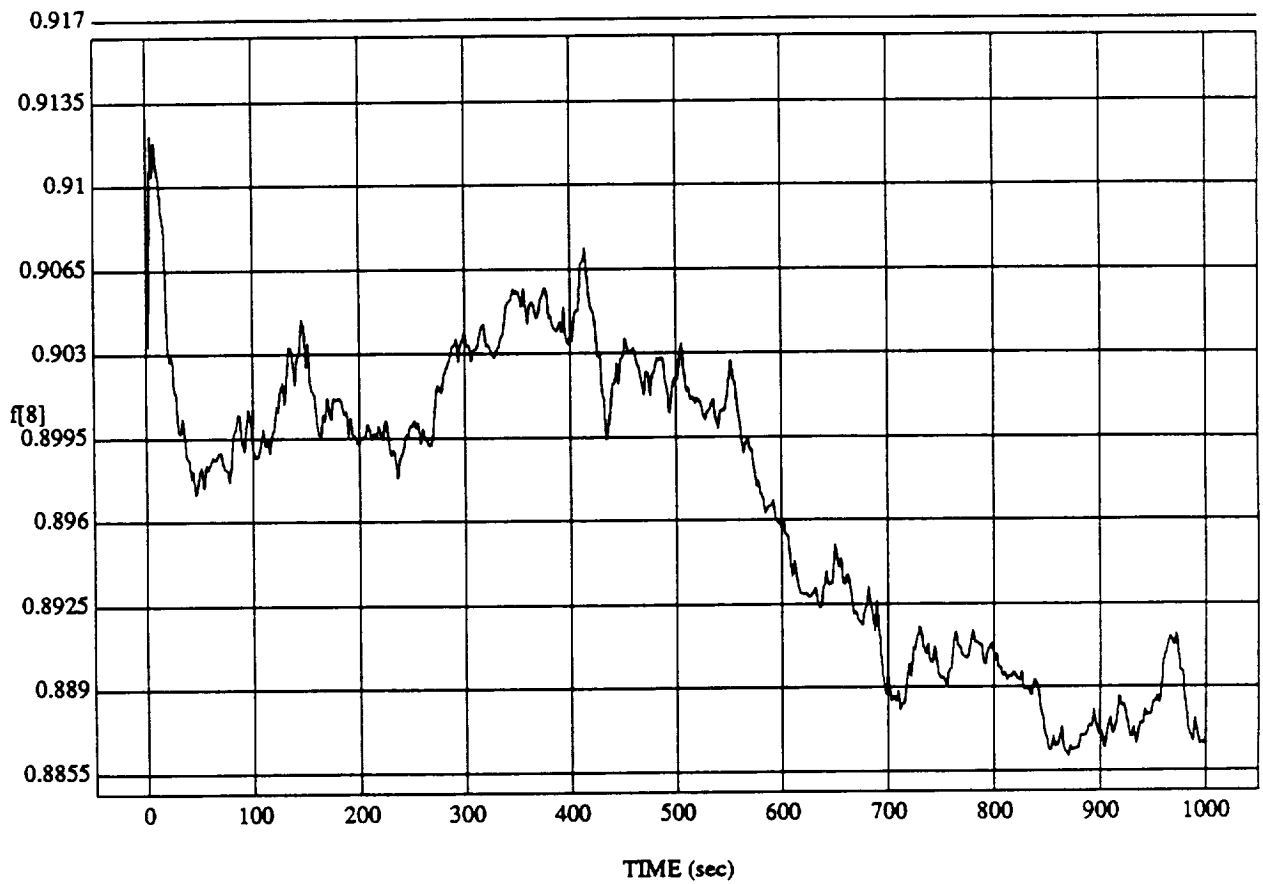


MODULE: ORB\_FUZZ\_BATCH.1cam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[8]$  vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

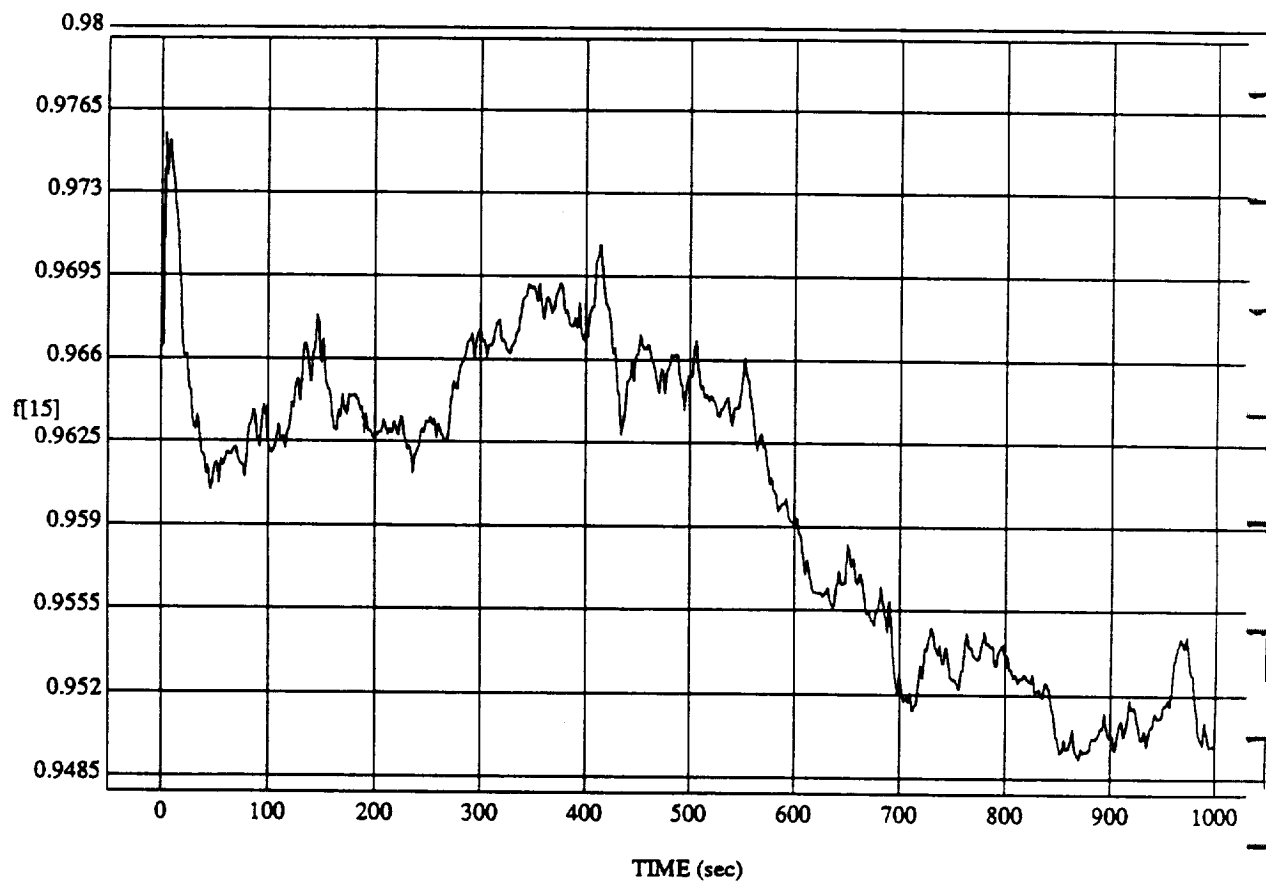


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[15] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

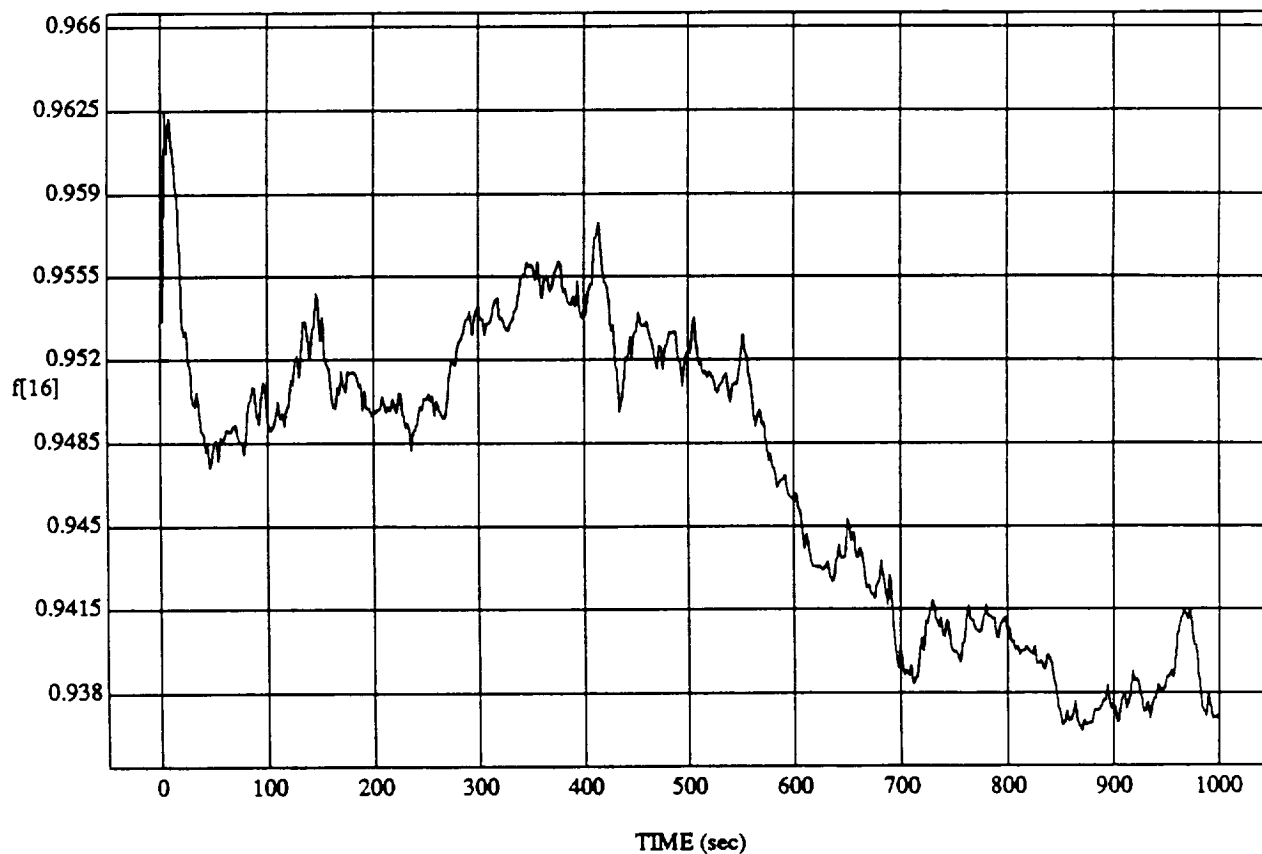


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[16]$  vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

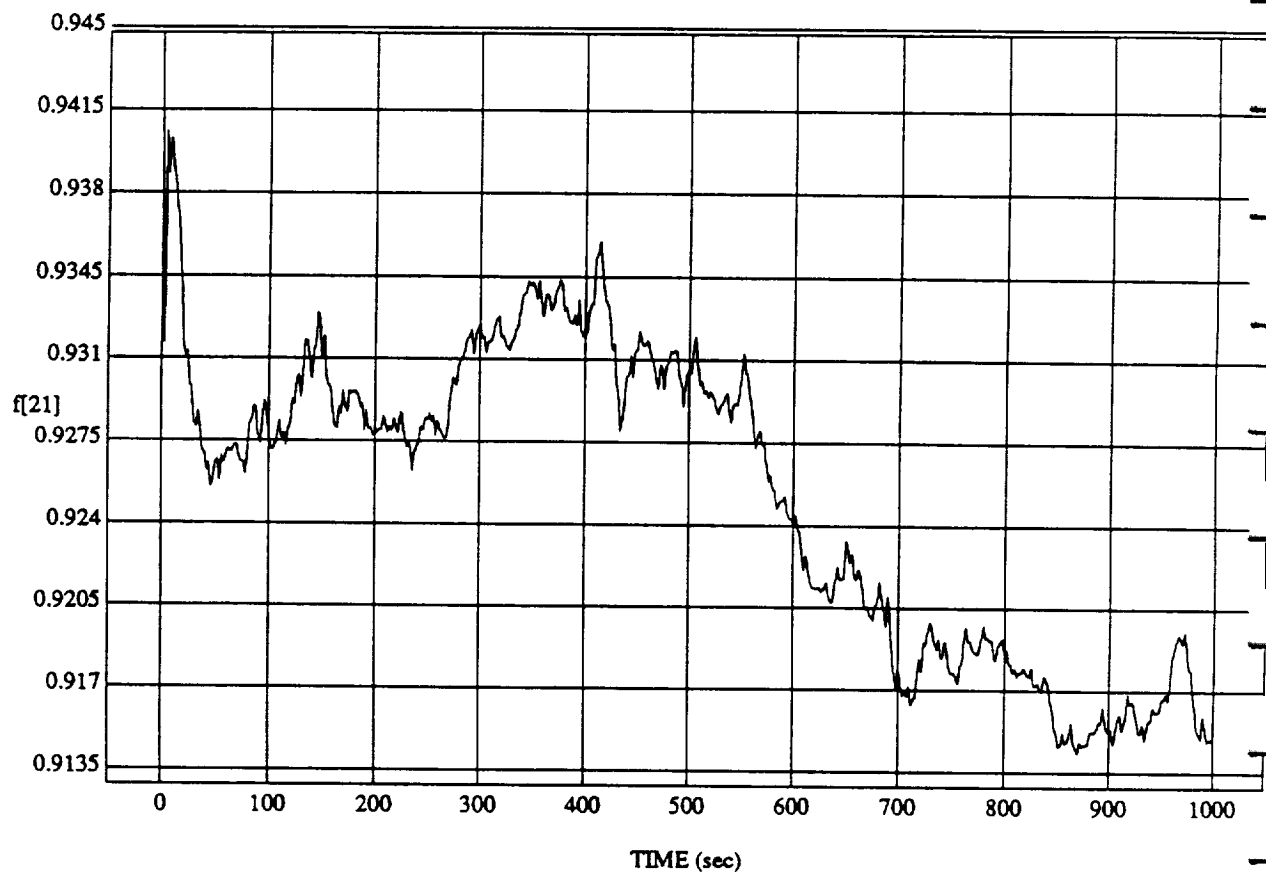


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[21] vs TIME

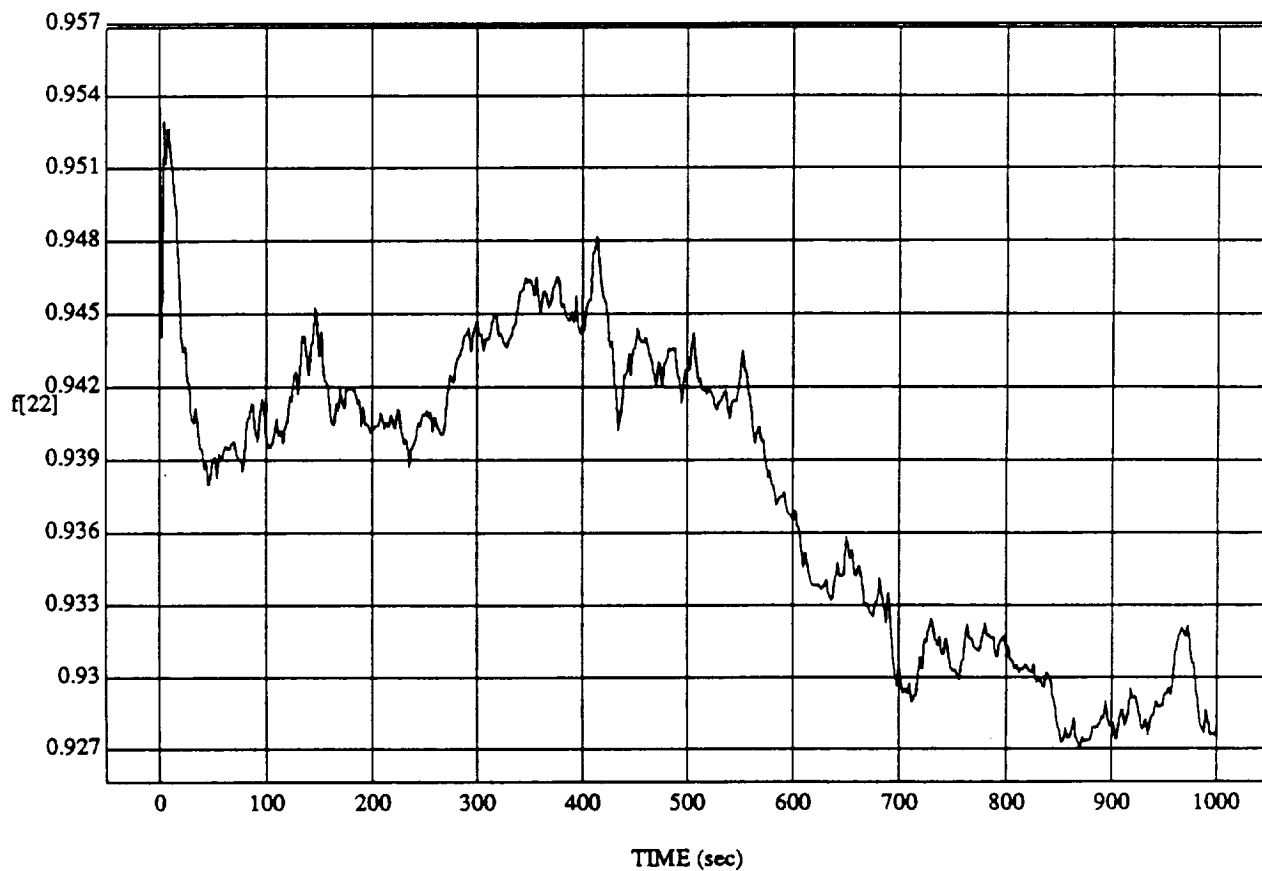
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[22]$  vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

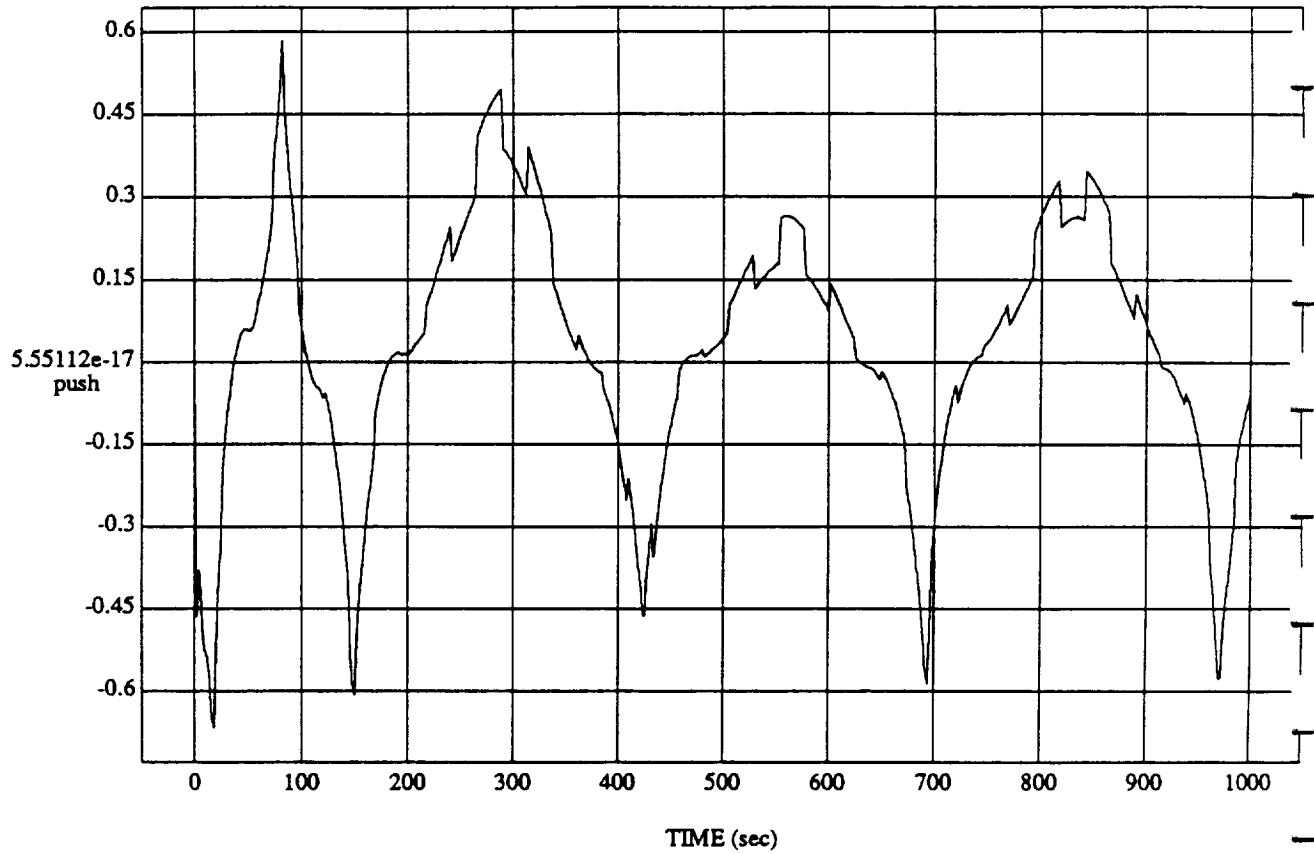


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

push vs TIME

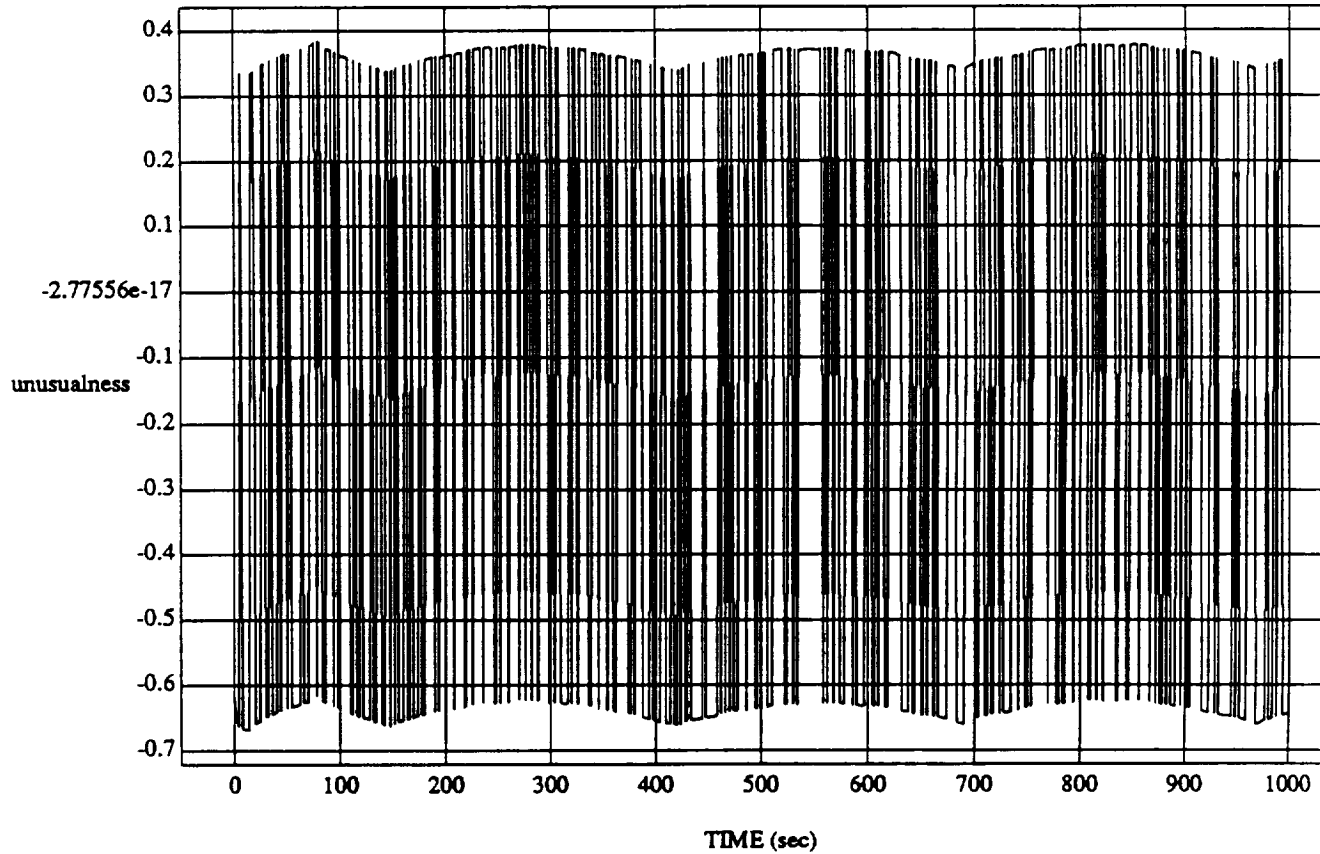
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

unusualness vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

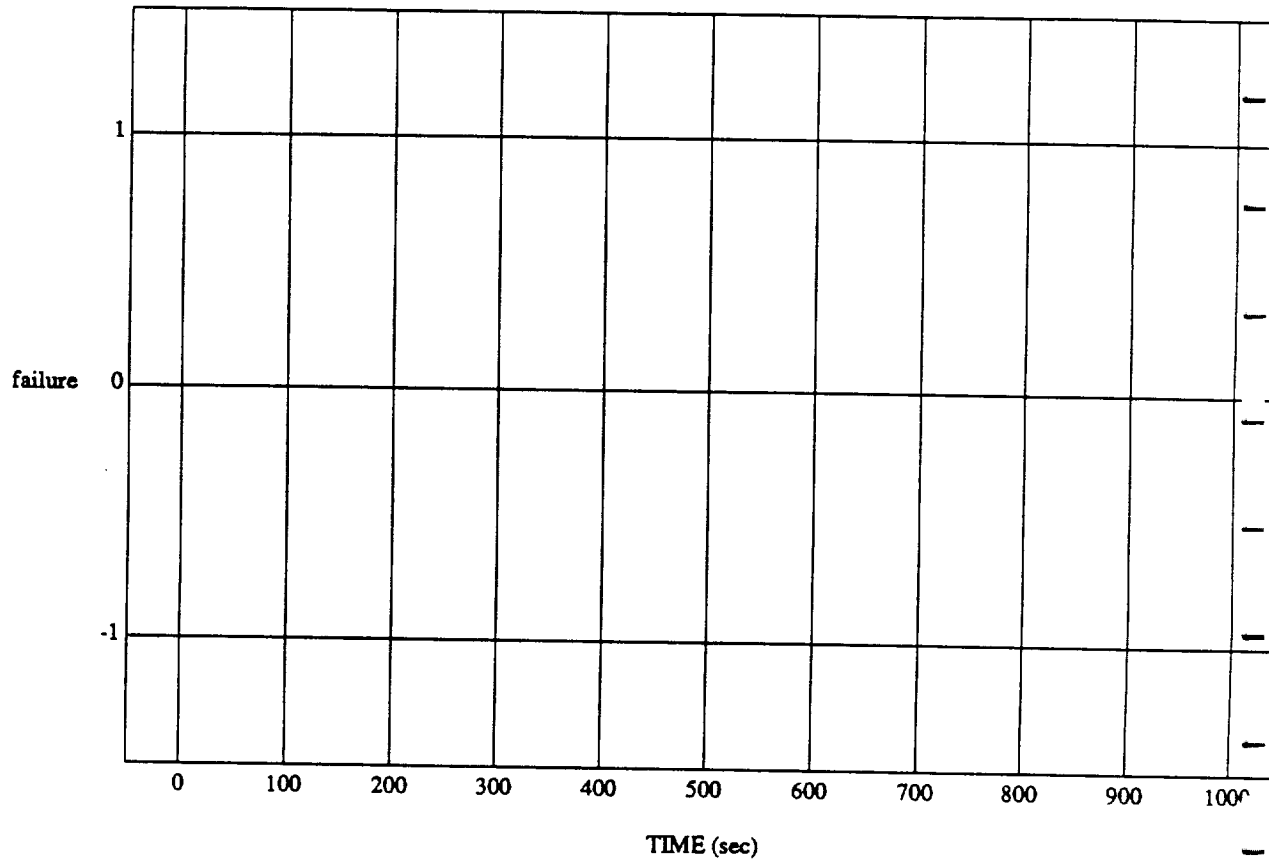


MODULE: ORB\_FUZZ\_BATCHlearn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

failure vs TIME

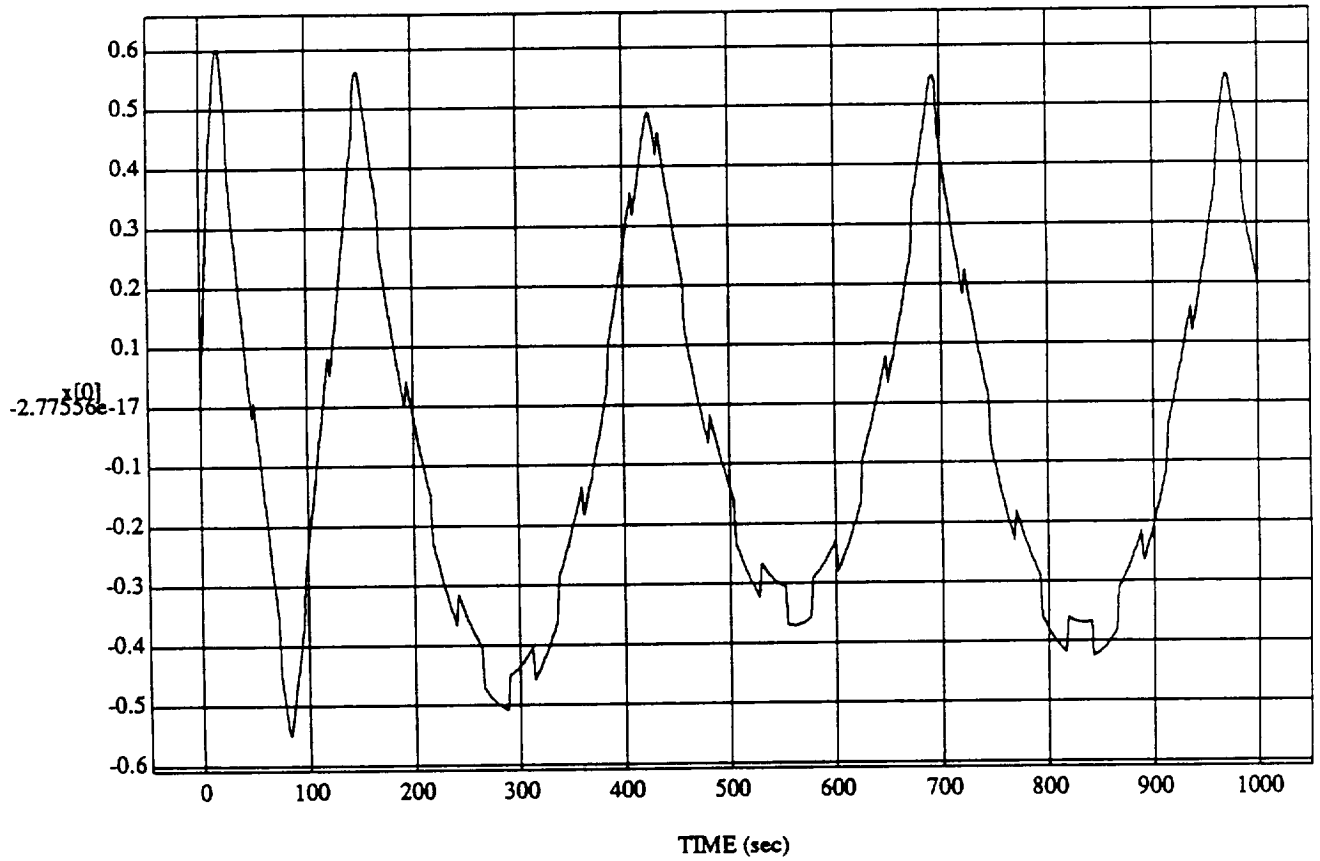
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$x[0]$  vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

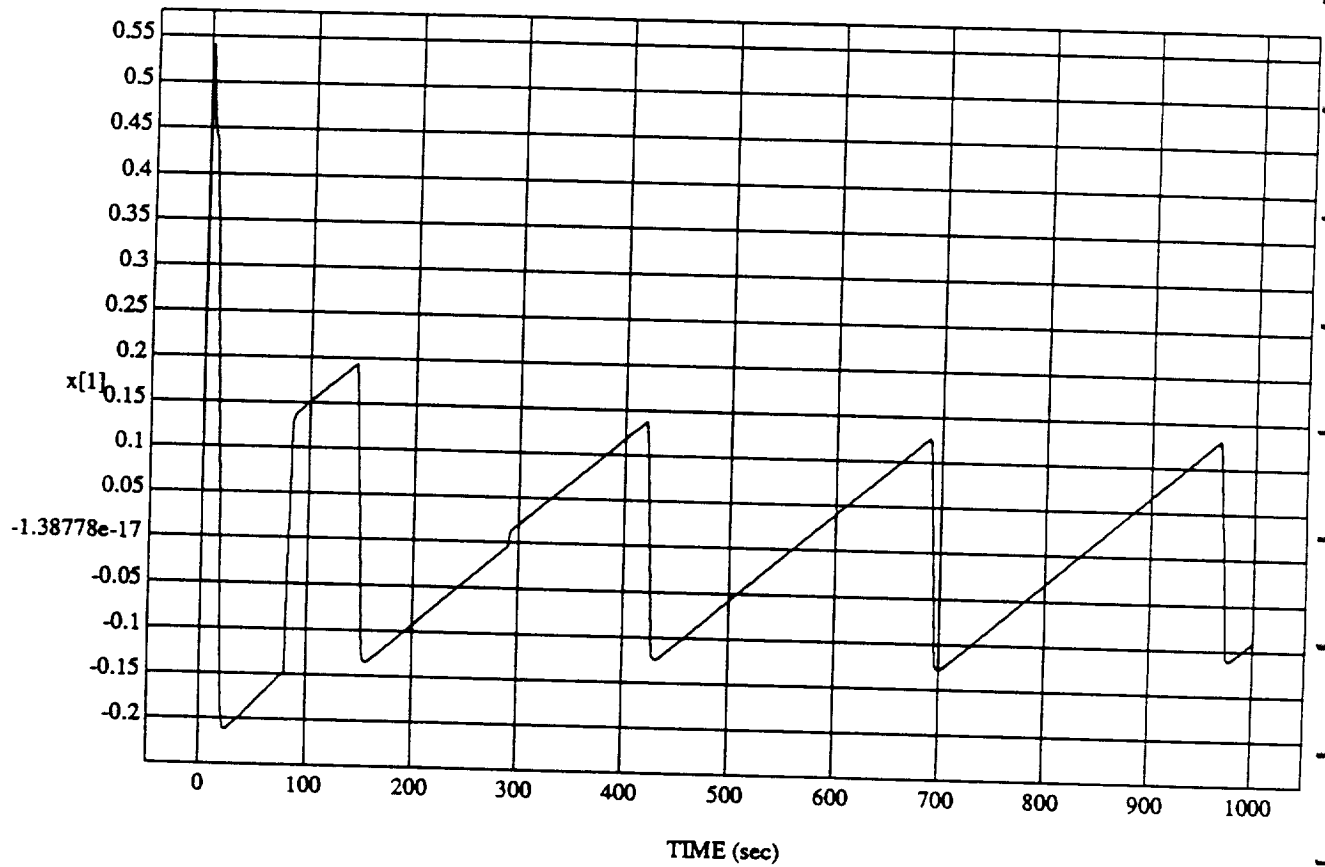


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$x[1]$  vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

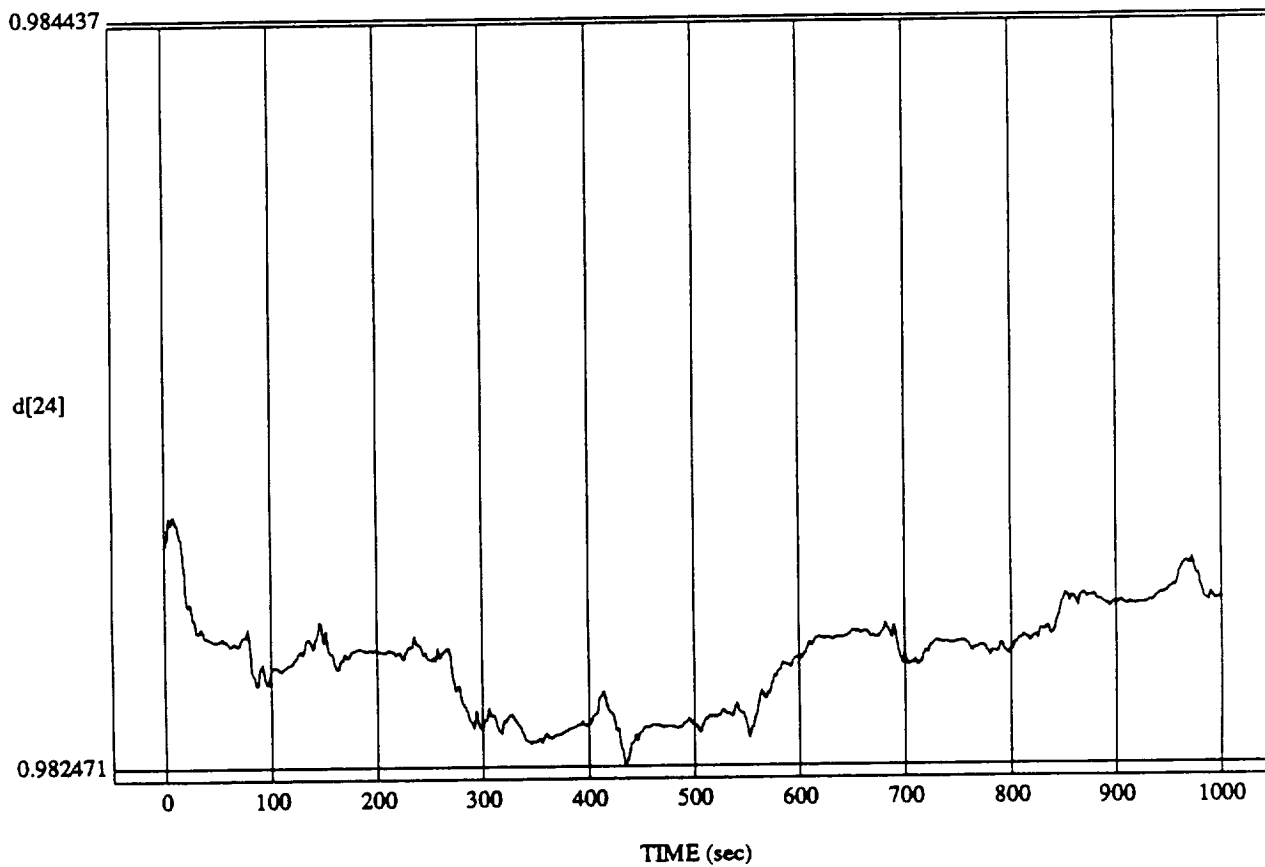


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[24] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

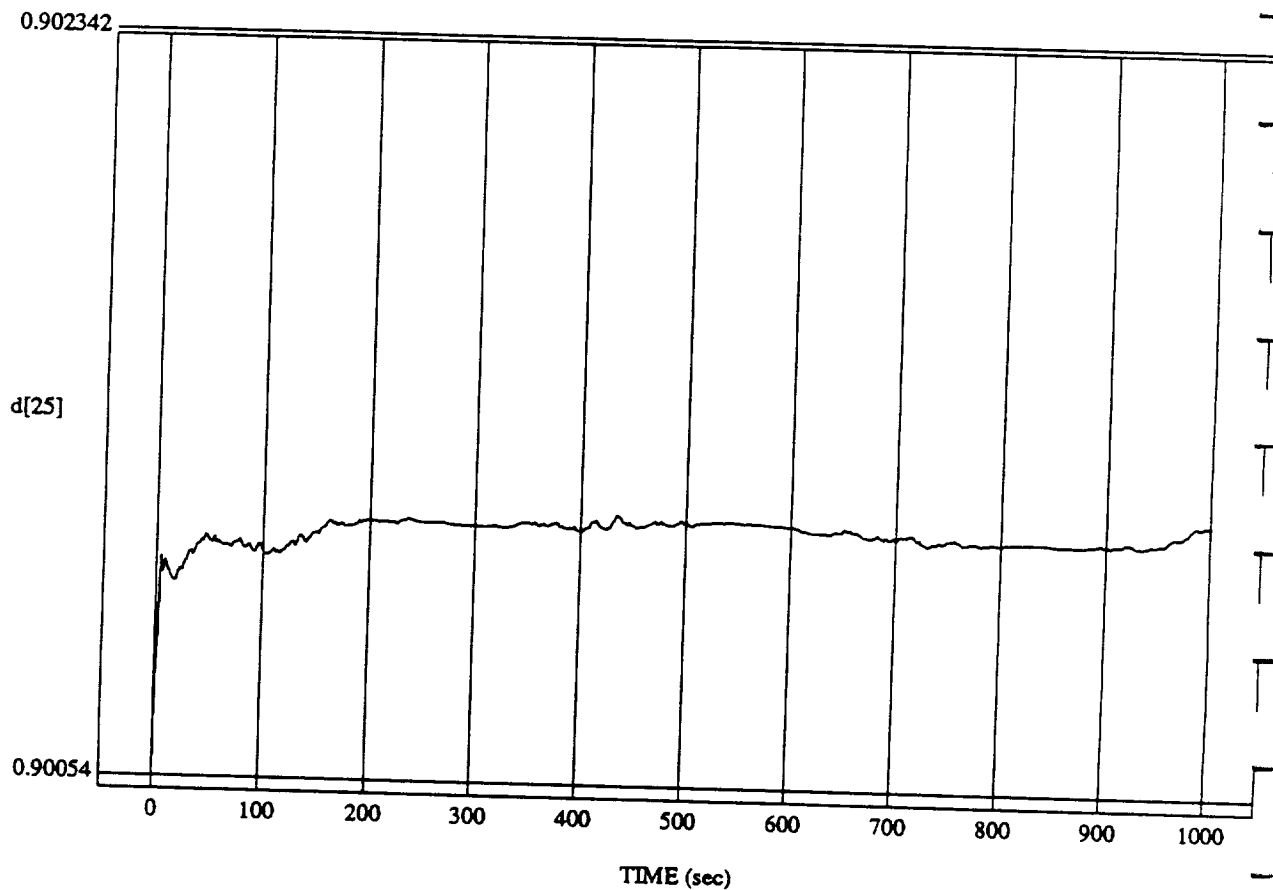


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[25] vs TIME

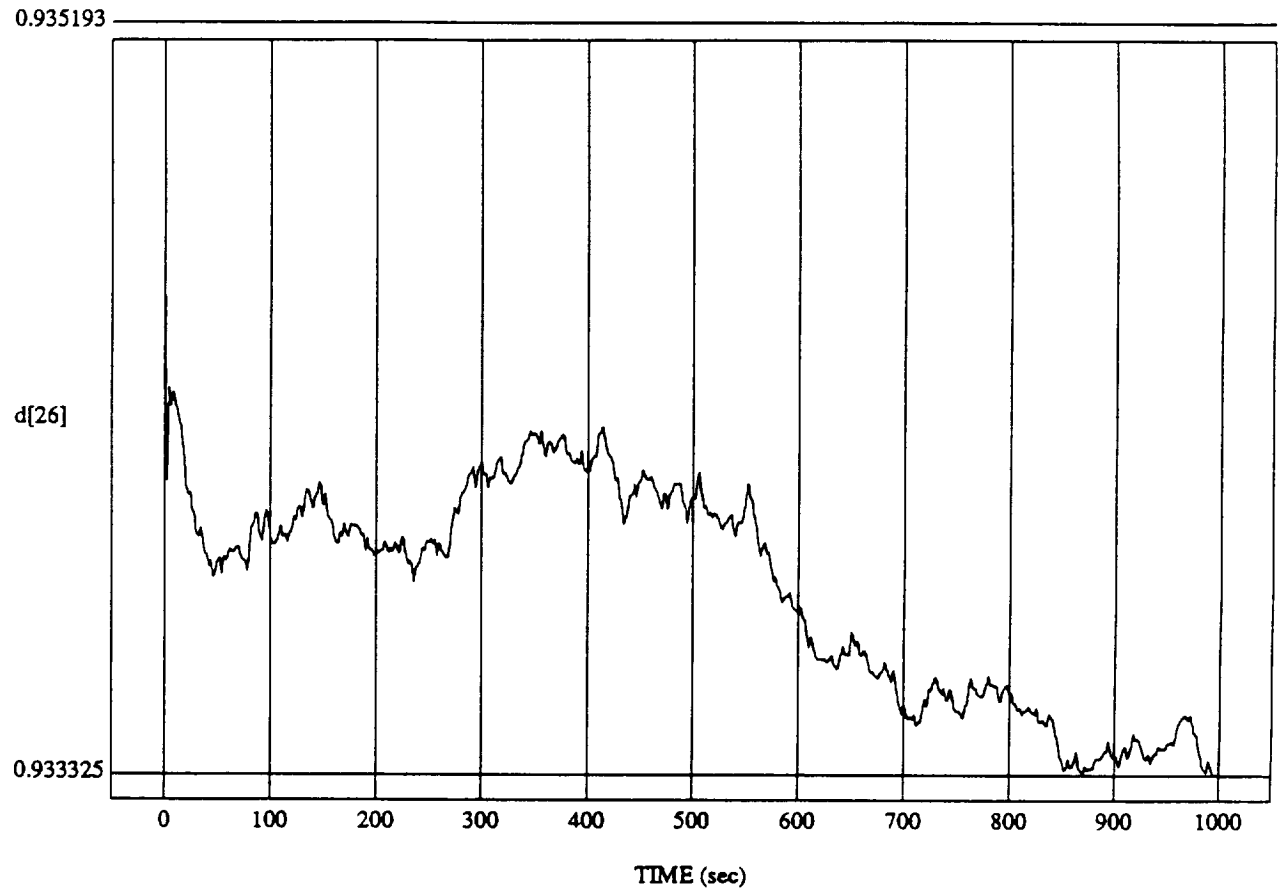
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[26] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

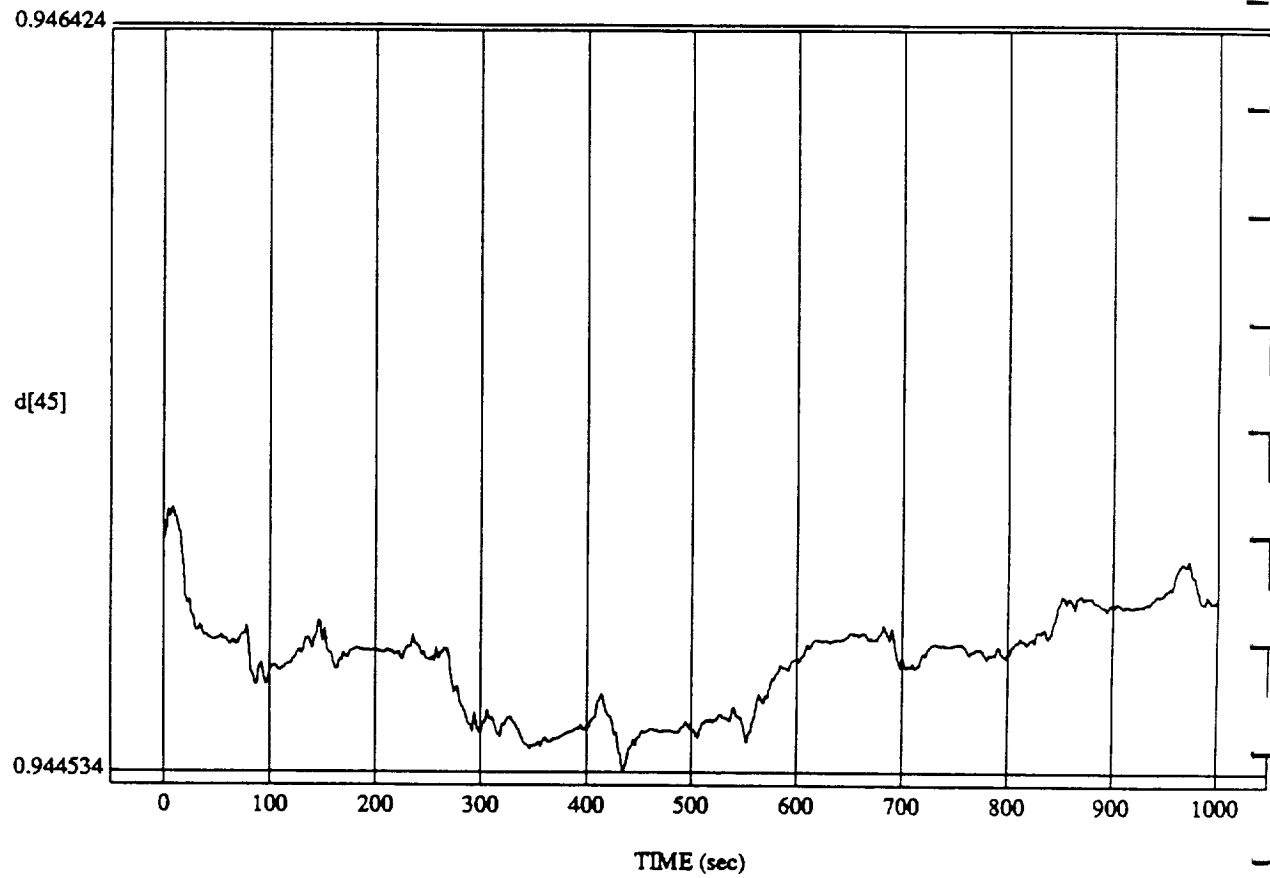


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[45] vs TIME

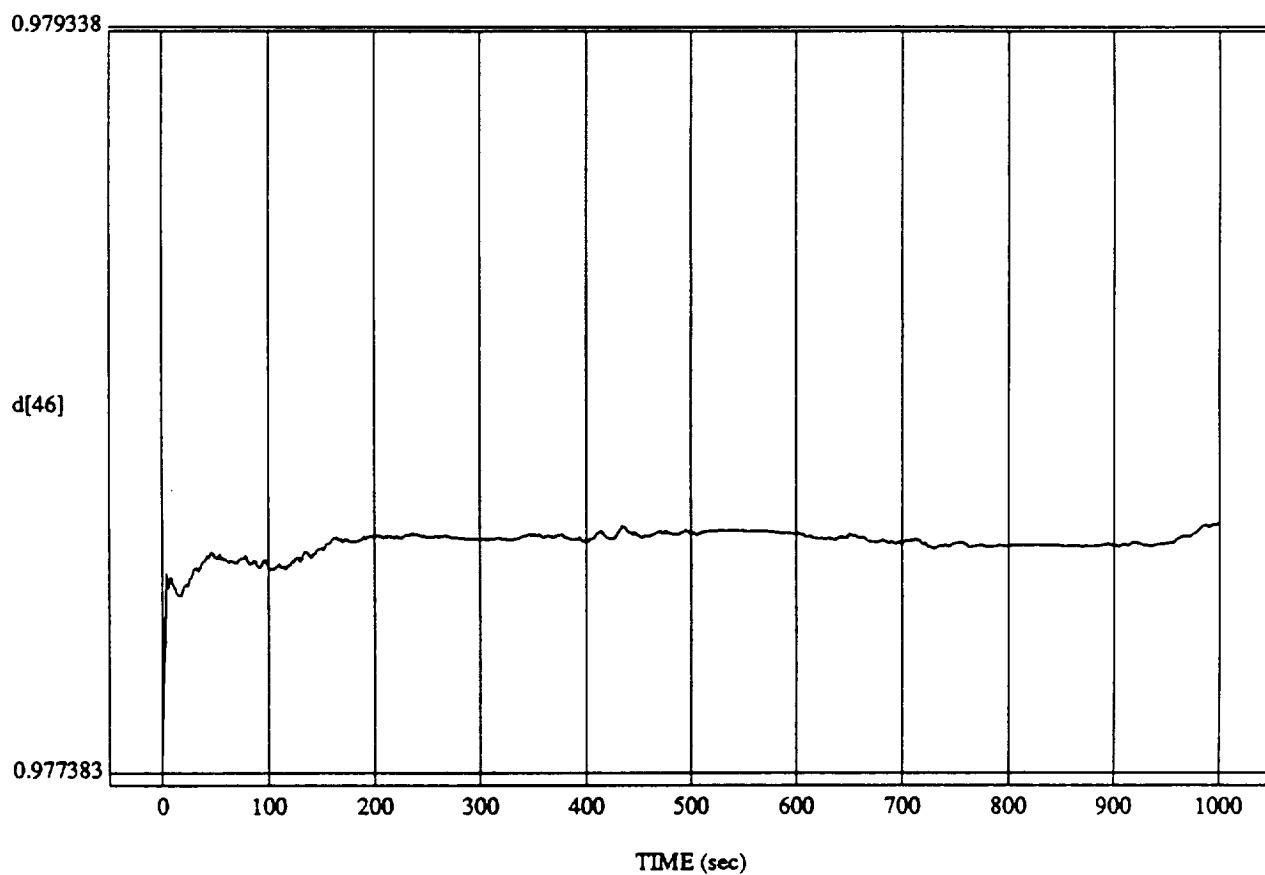
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[46] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

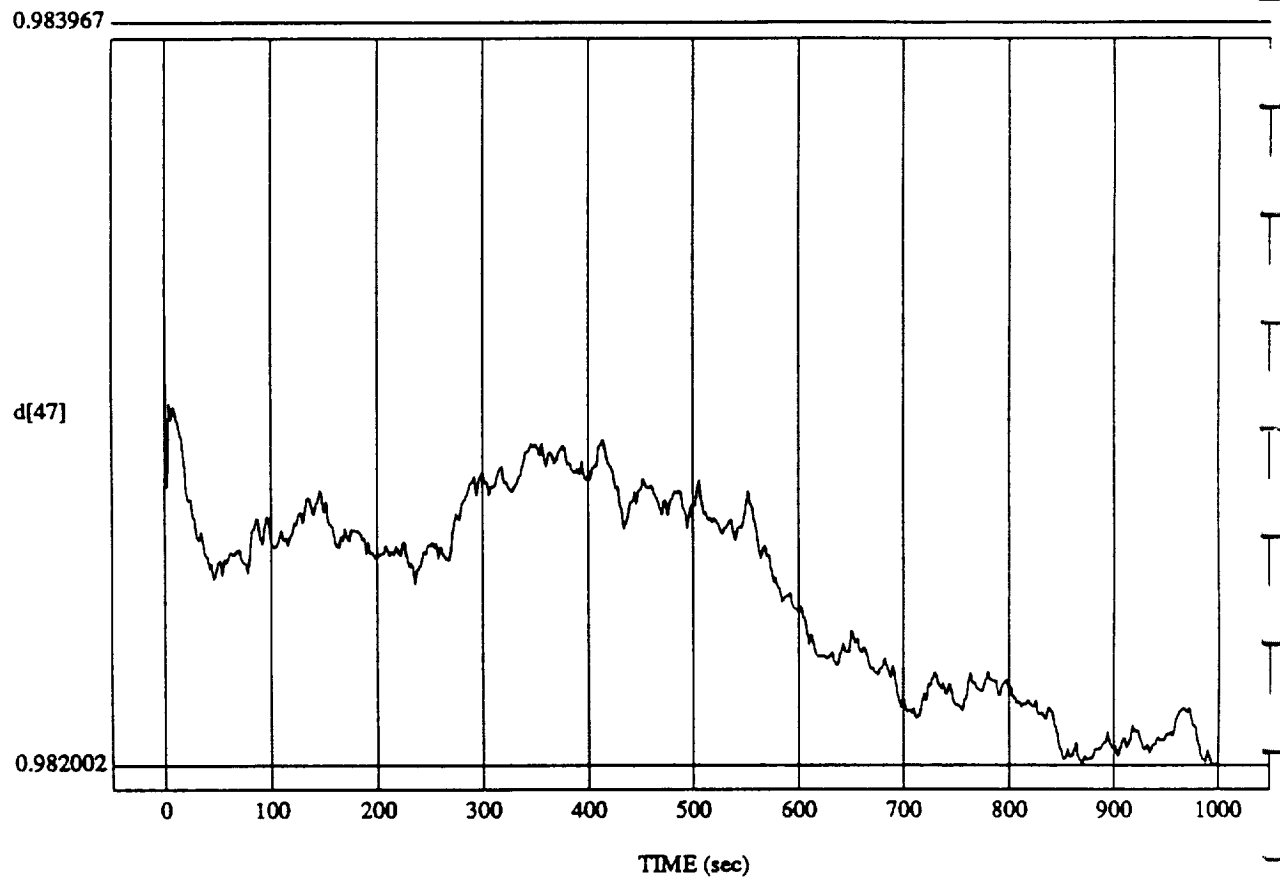


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[47] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

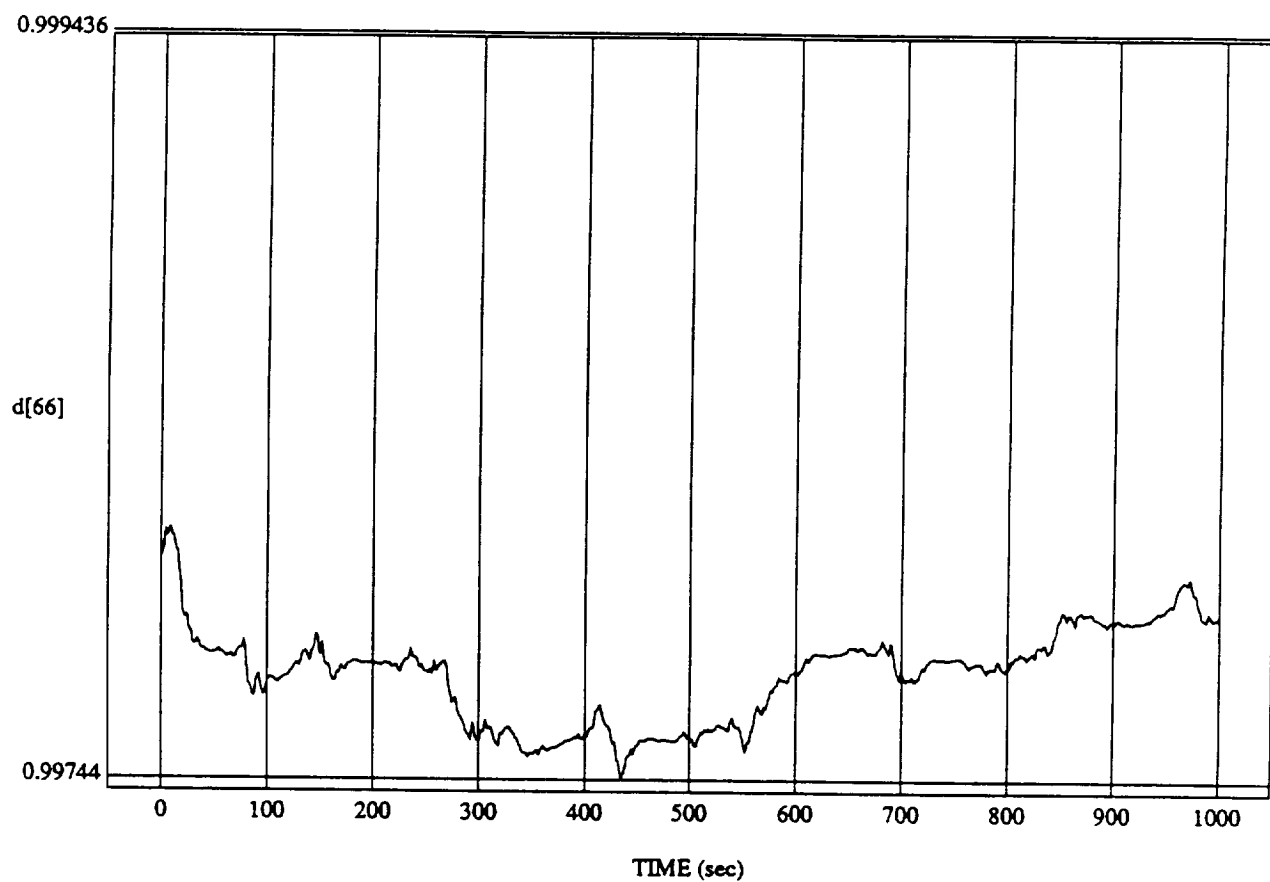


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[66] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

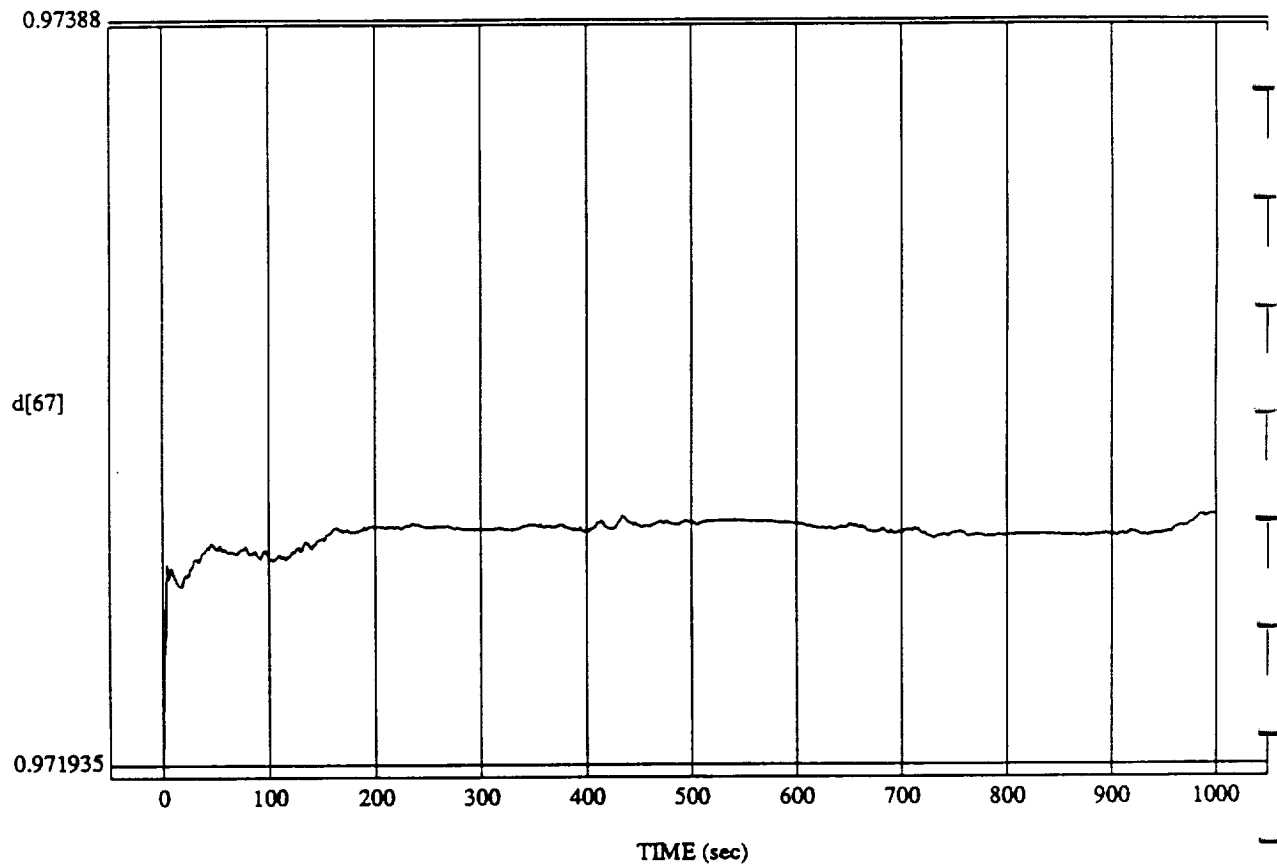


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[67] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

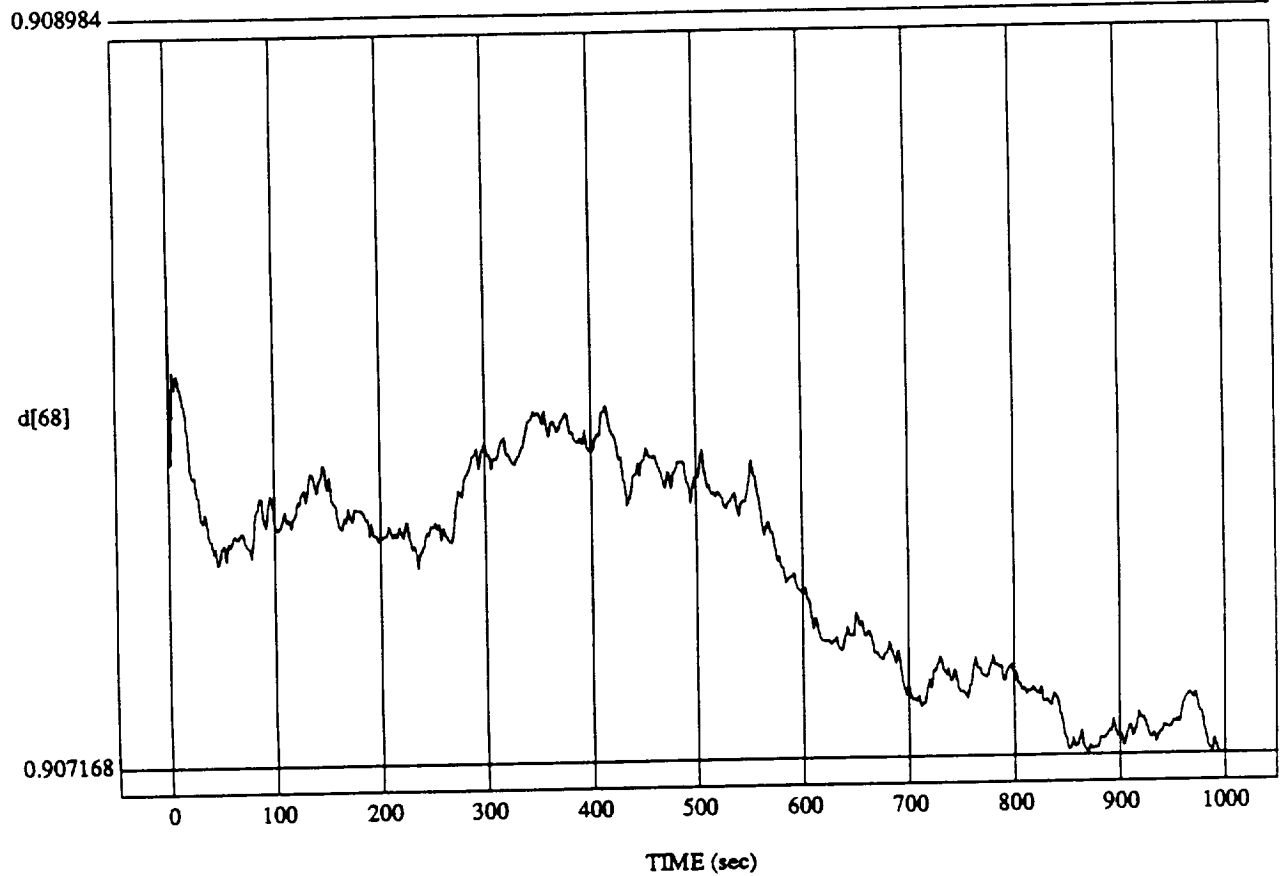


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[68] vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz



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 102. **Acknowledgments**  
 103. **Author Contributions**  
 104. **Correspondence**  
 105. **References**  
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 140. **Abstract**  
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 247. **Notes**  
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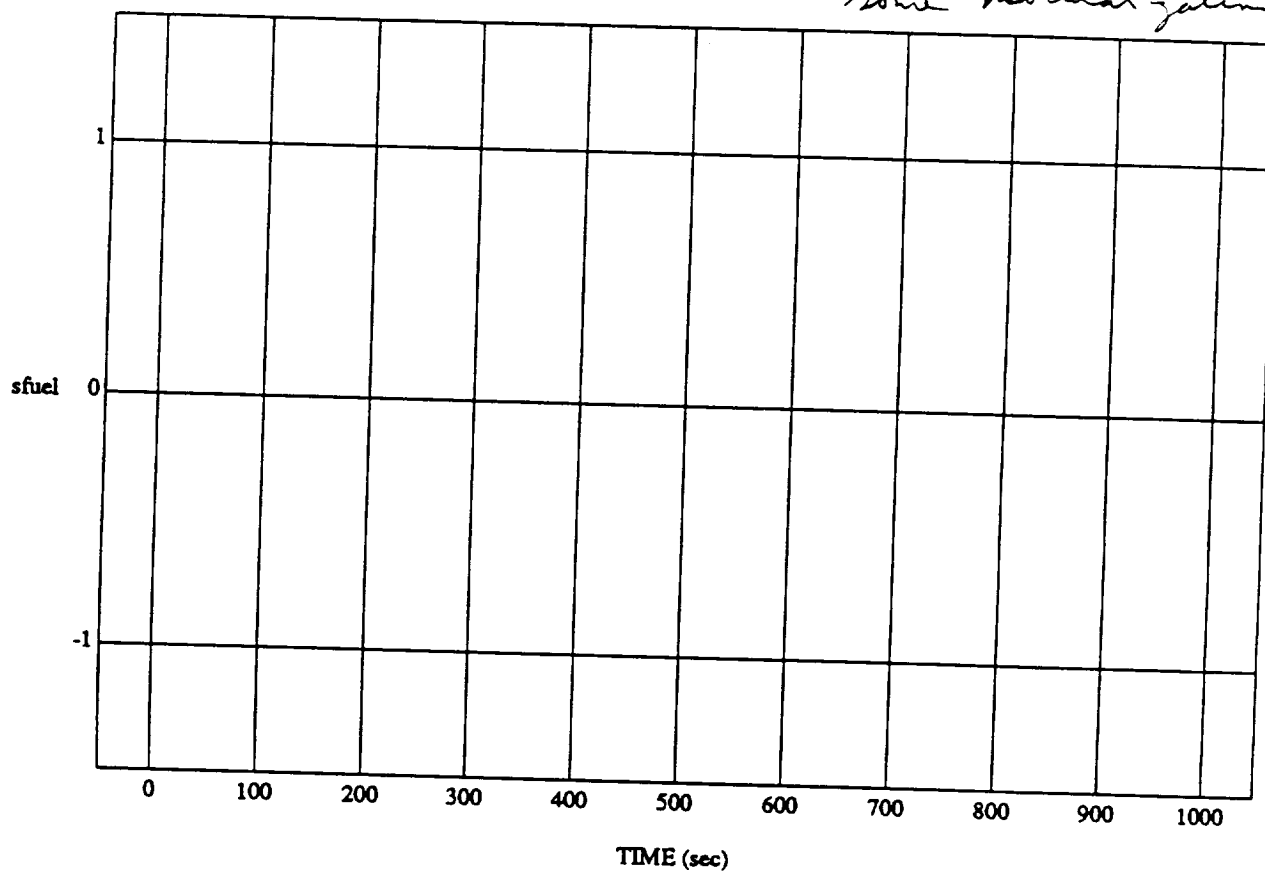
VI

## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME

*learn rate 0.2*

RUN: Fuzzy / NN Learner - Rnd D's &amp; Norm SUM3 - 4 May 1992

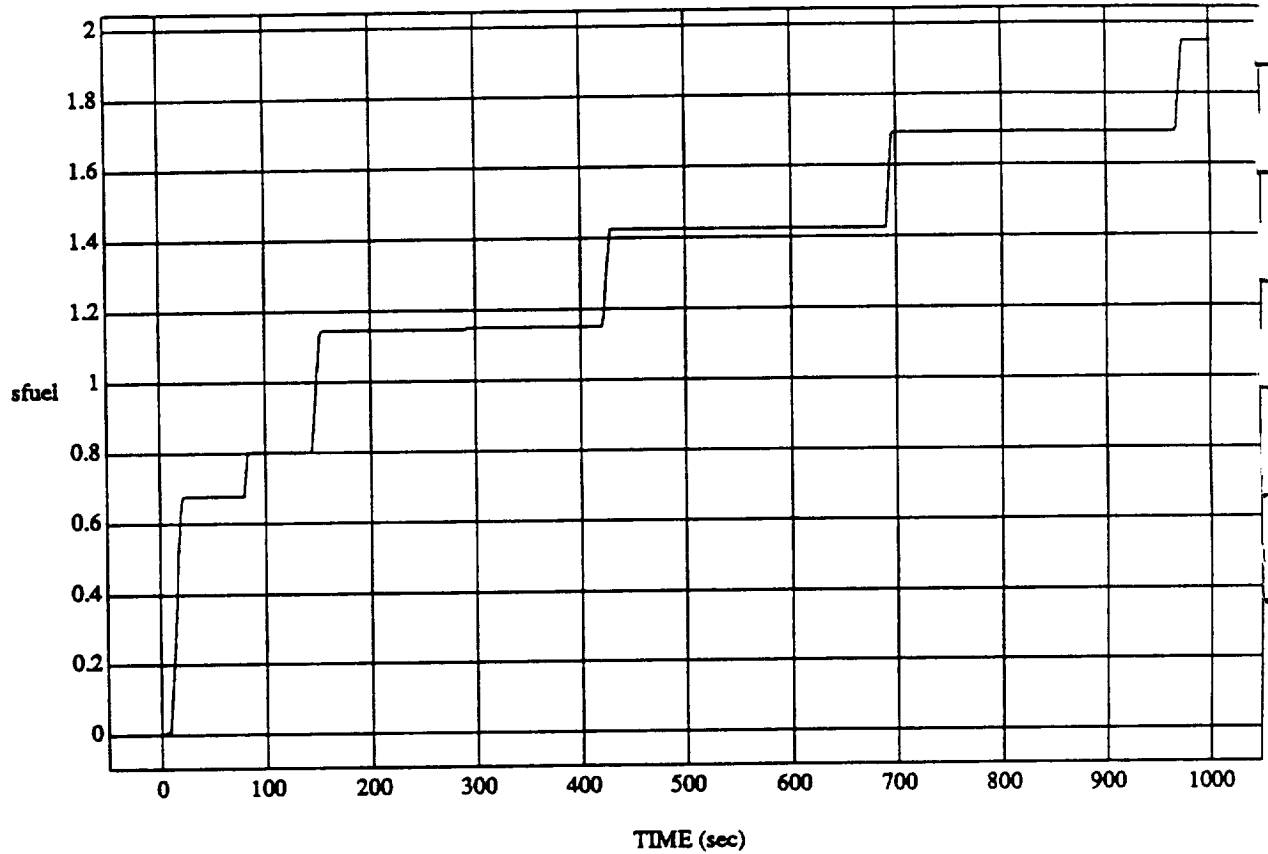
*some normalization*

MODULE: ORB\_FUZZ\_BATCH\_primary  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

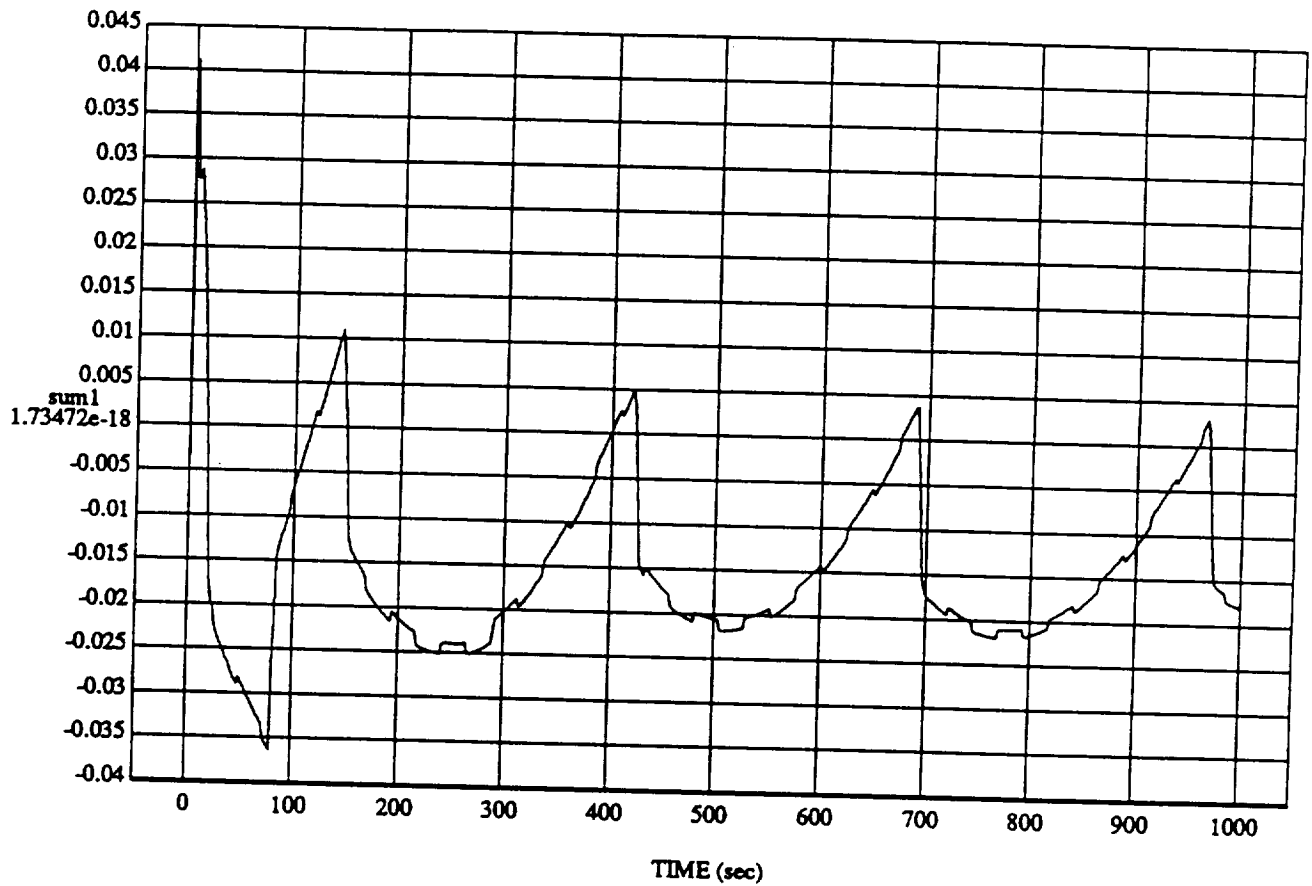


MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.500 Hz

## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

## sum1 vs TIME

RUN: Fuzzy / NN Learner - Rnd D's &amp; Norm SUM3 - 4 May 1992

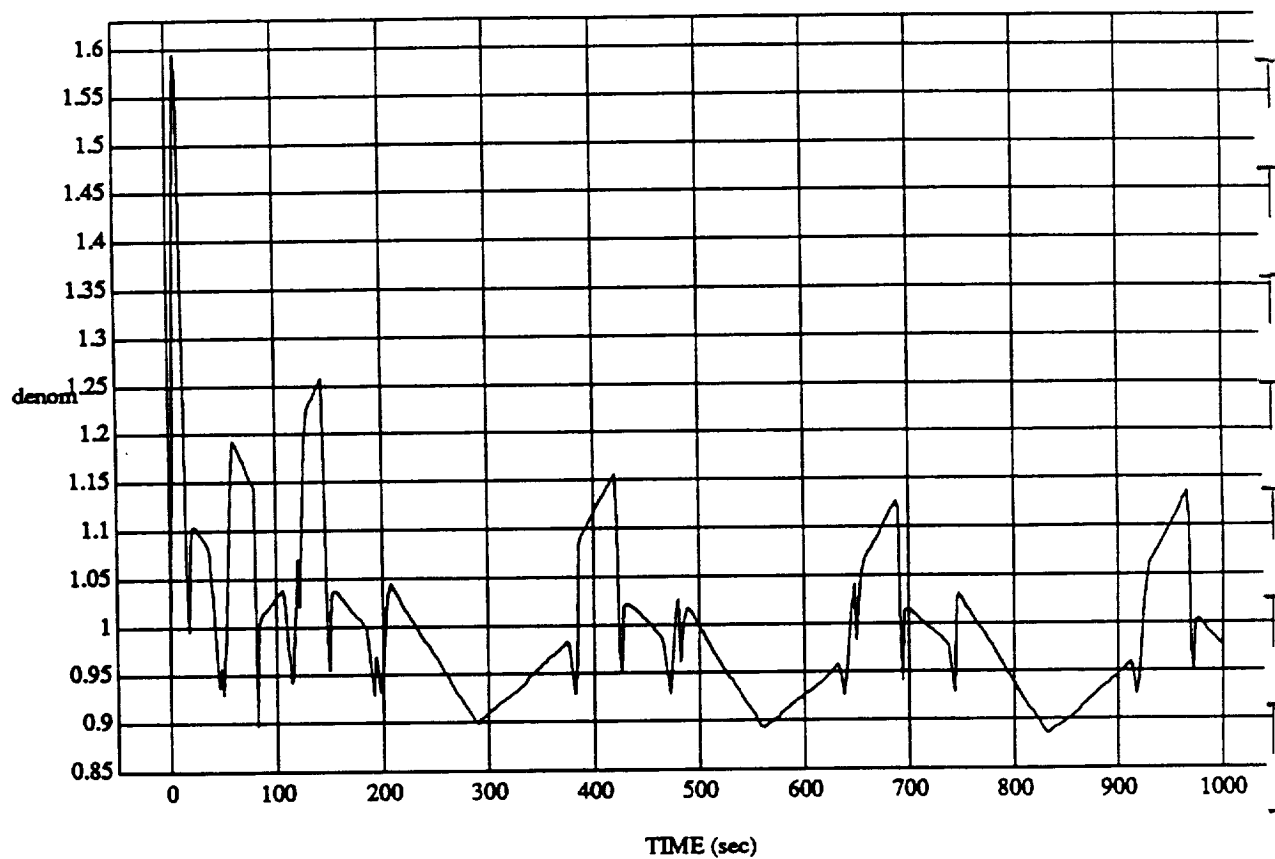


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

denom vs TIME

RUN: Fuzzy / NN Learner - Rnd D's &amp; Norm SUM3 - 4 May 1992



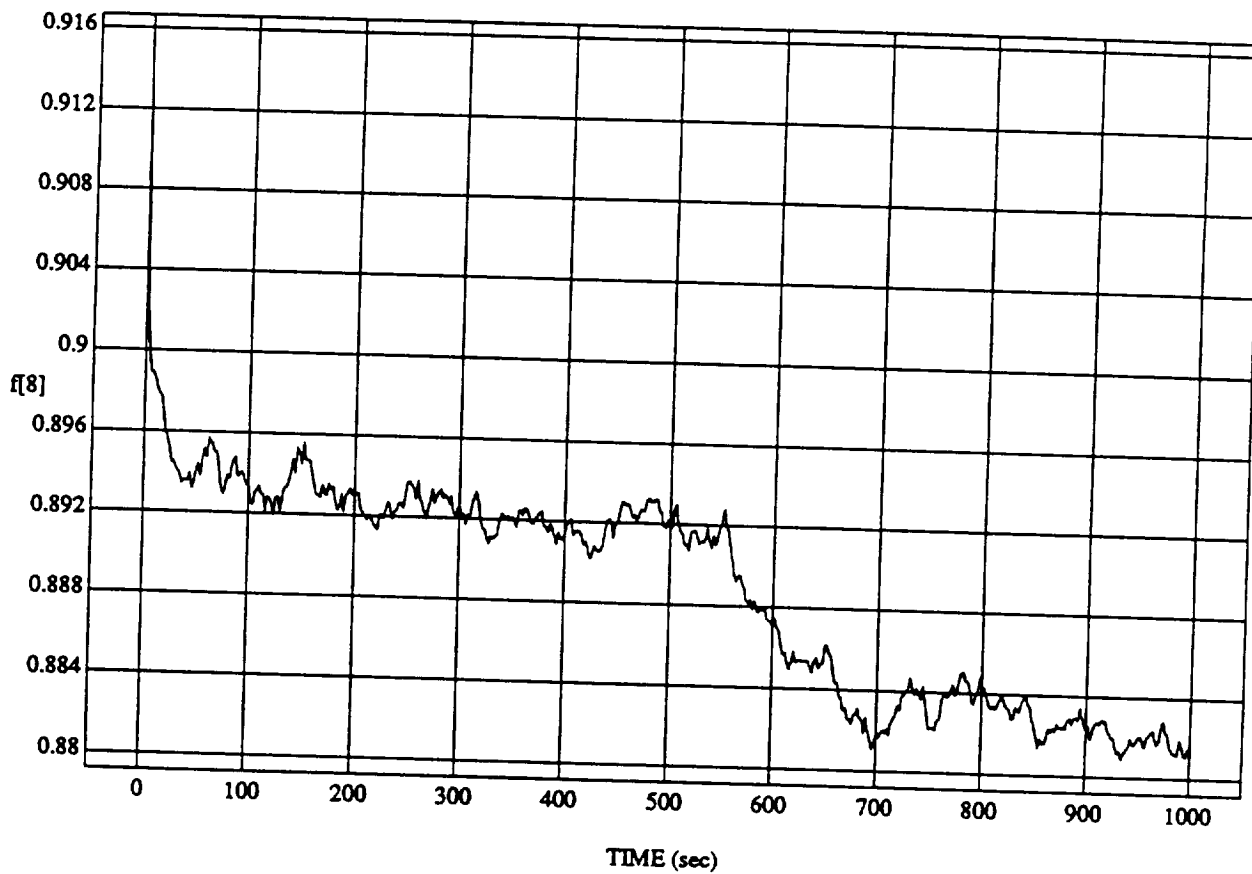
MODULE: ORB\_FUZZ\_BATCHlearn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

 $f[8]$  vs TIME

RUN: Fuzzy / NN Learner - Rnd D's &amp; Norm SUM3 - 4 May 1992

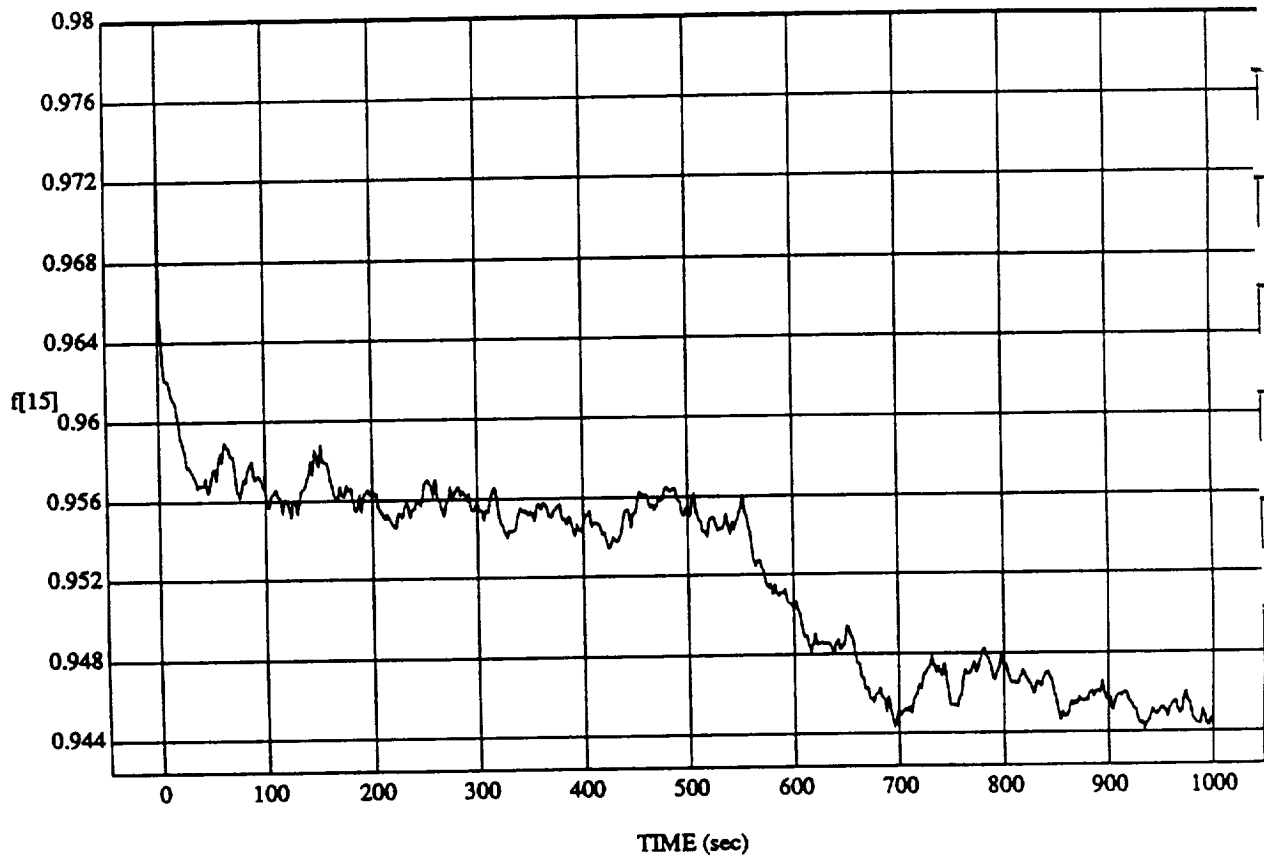


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[15] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's &amp; Norm SUM3 - 4 May 1992

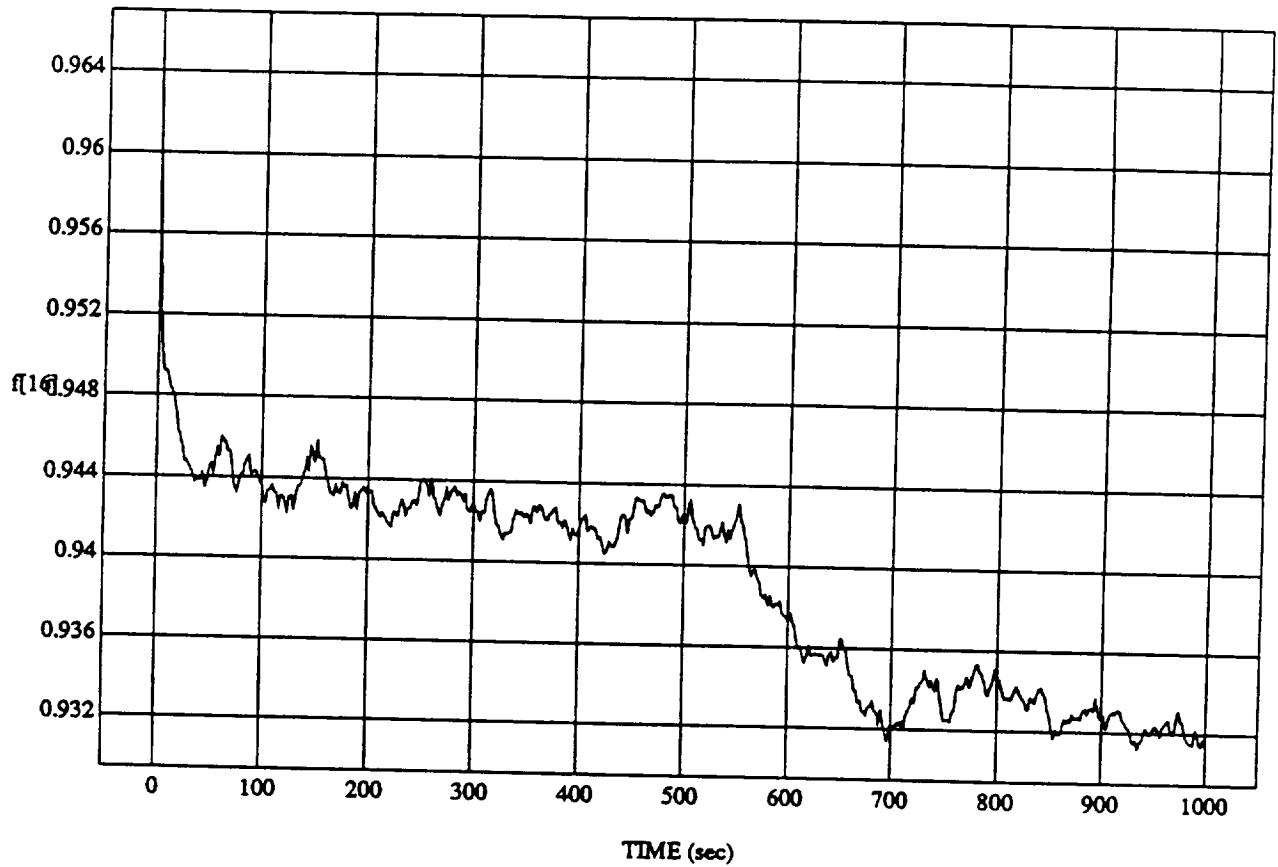


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[16] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's &amp; Norm SUM3 - 4 May 1992



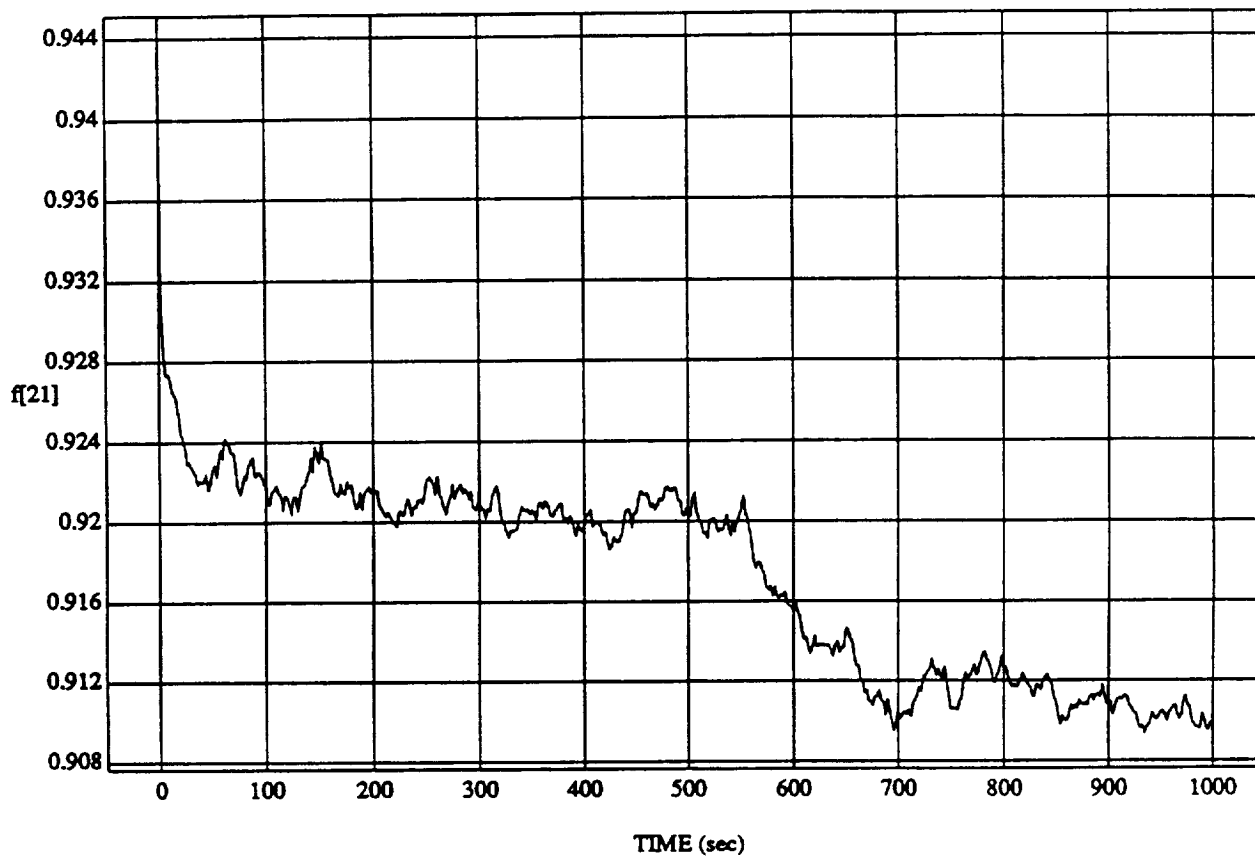
MODULE: ORB\_FUZZ\_BATCH.lear2

DATA SAMPLING FREQUENCY: 0.500 Hz

## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[21] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's &amp; Norm SUM3 - 4 May 1992

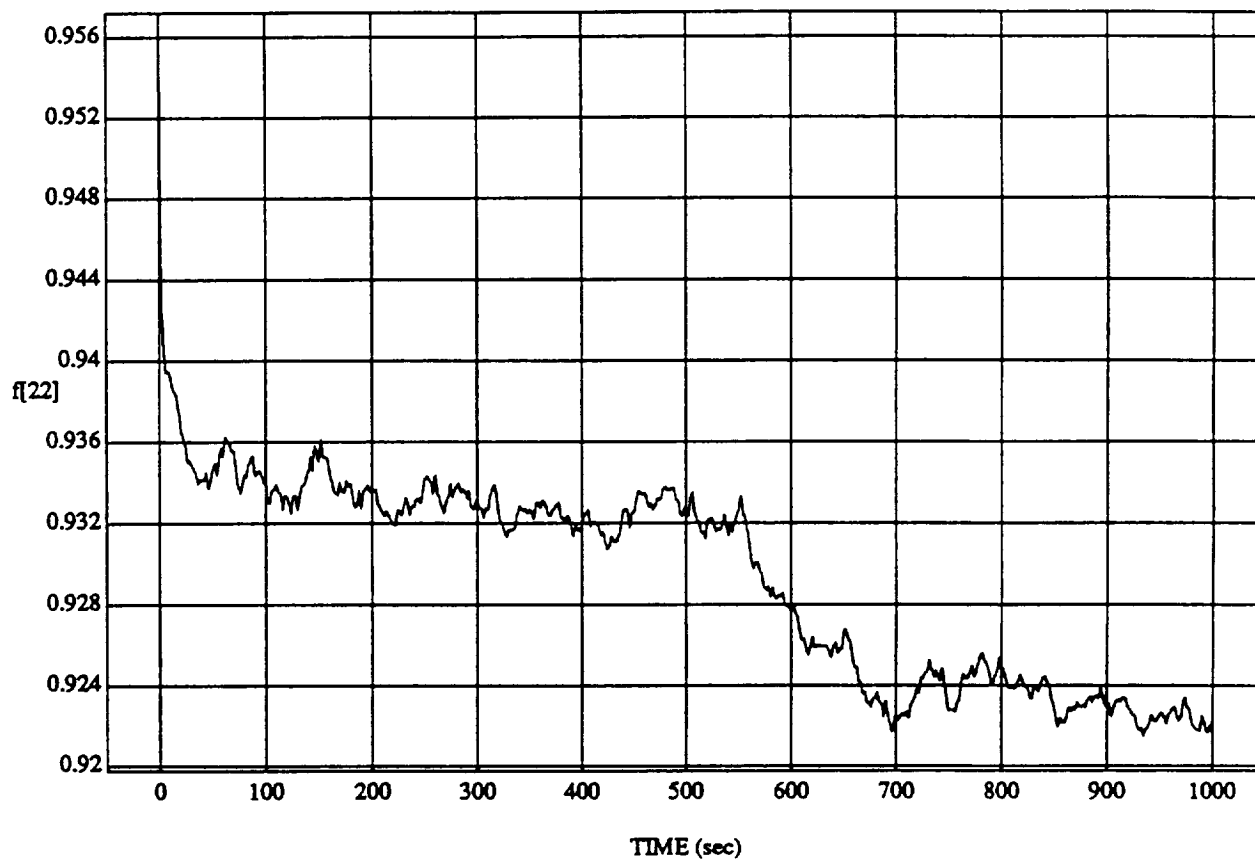


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[22] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



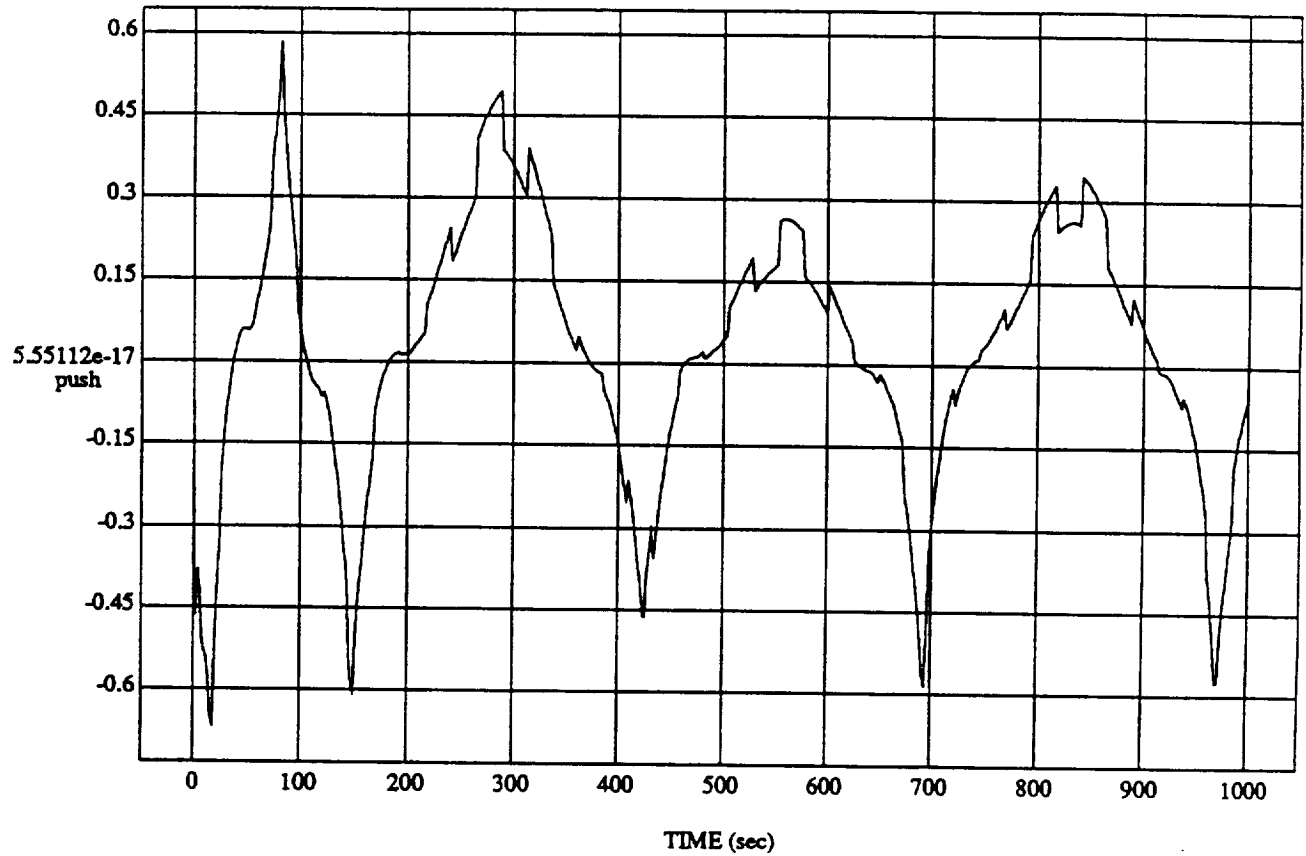
MODULE: ORB\_FUZZ\_BATCH.learm2

DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

push vs TIME

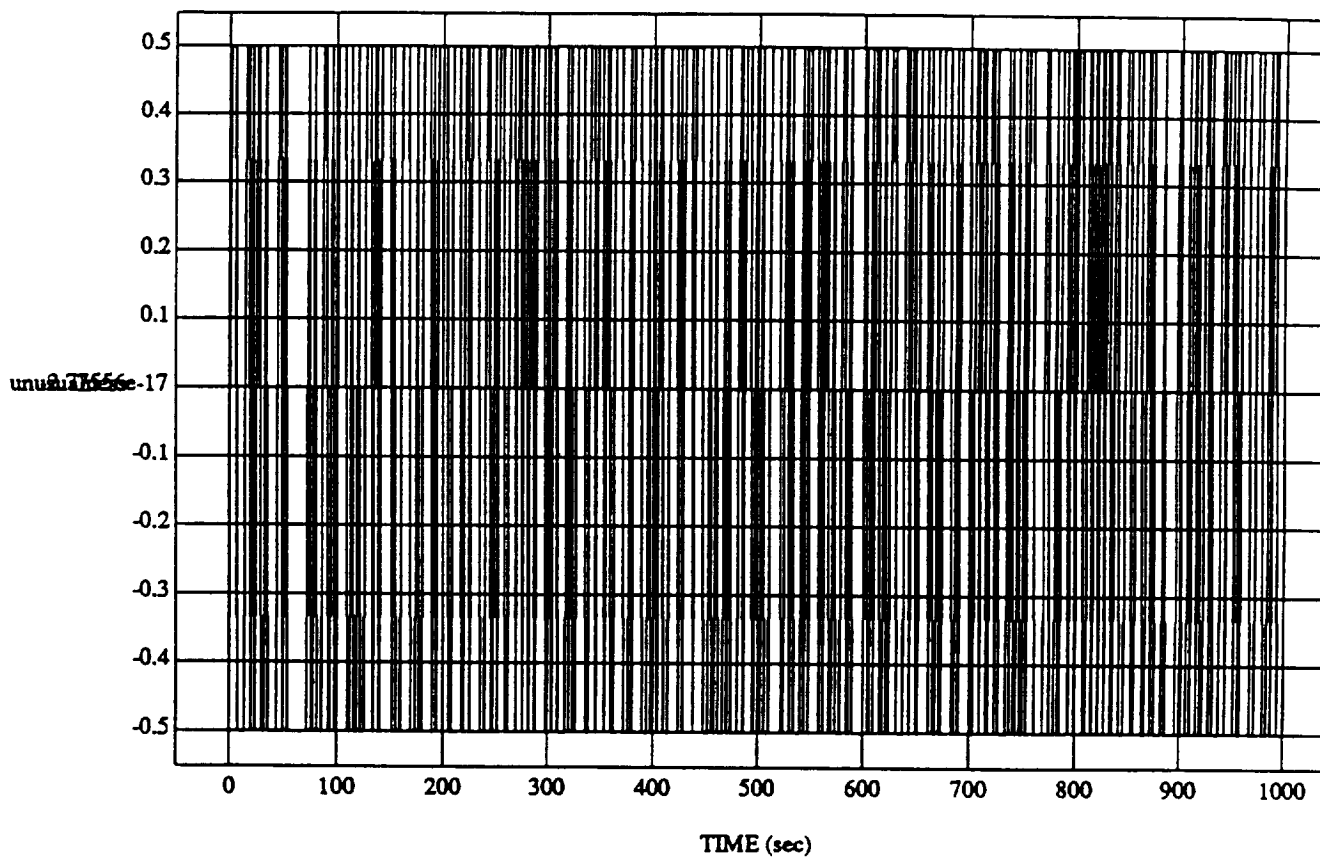
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCHlearn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

unusualness vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

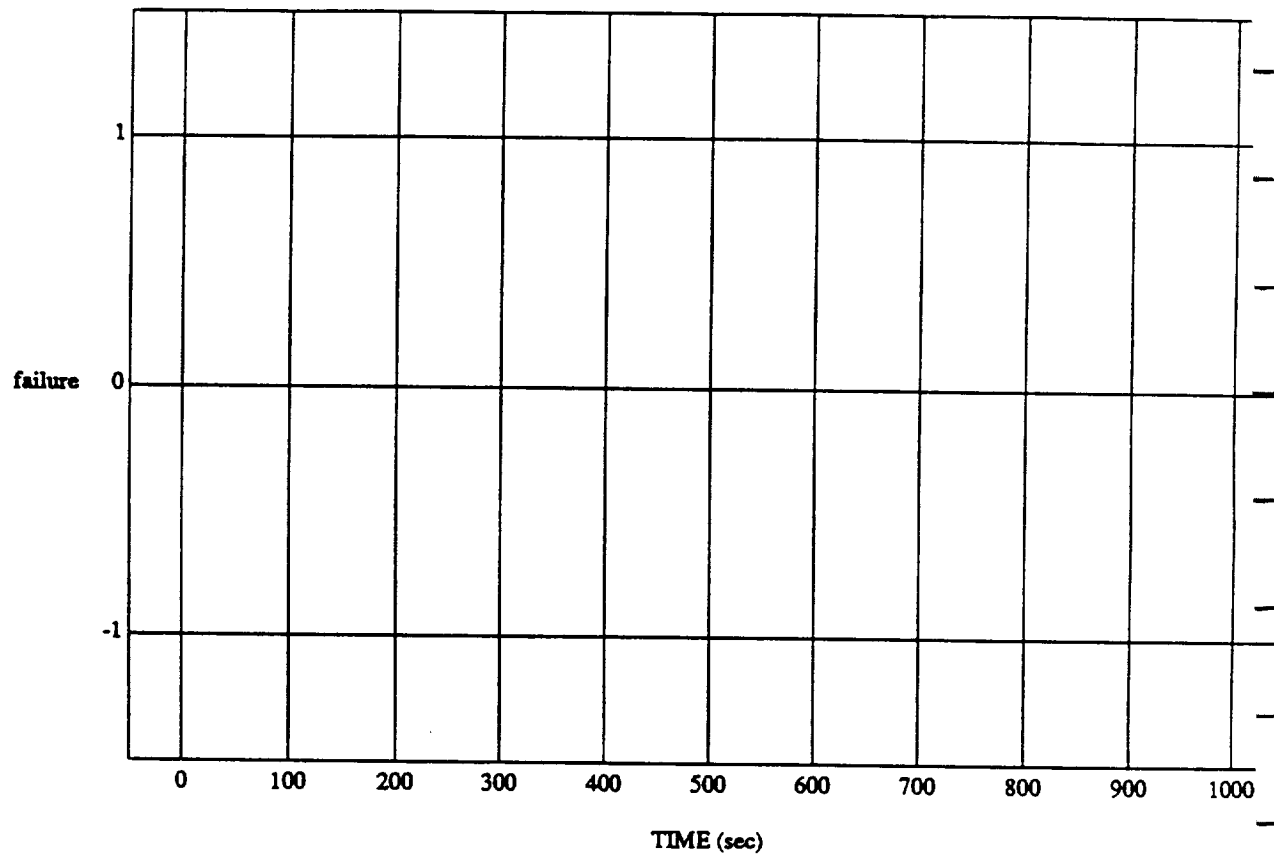


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

failure vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



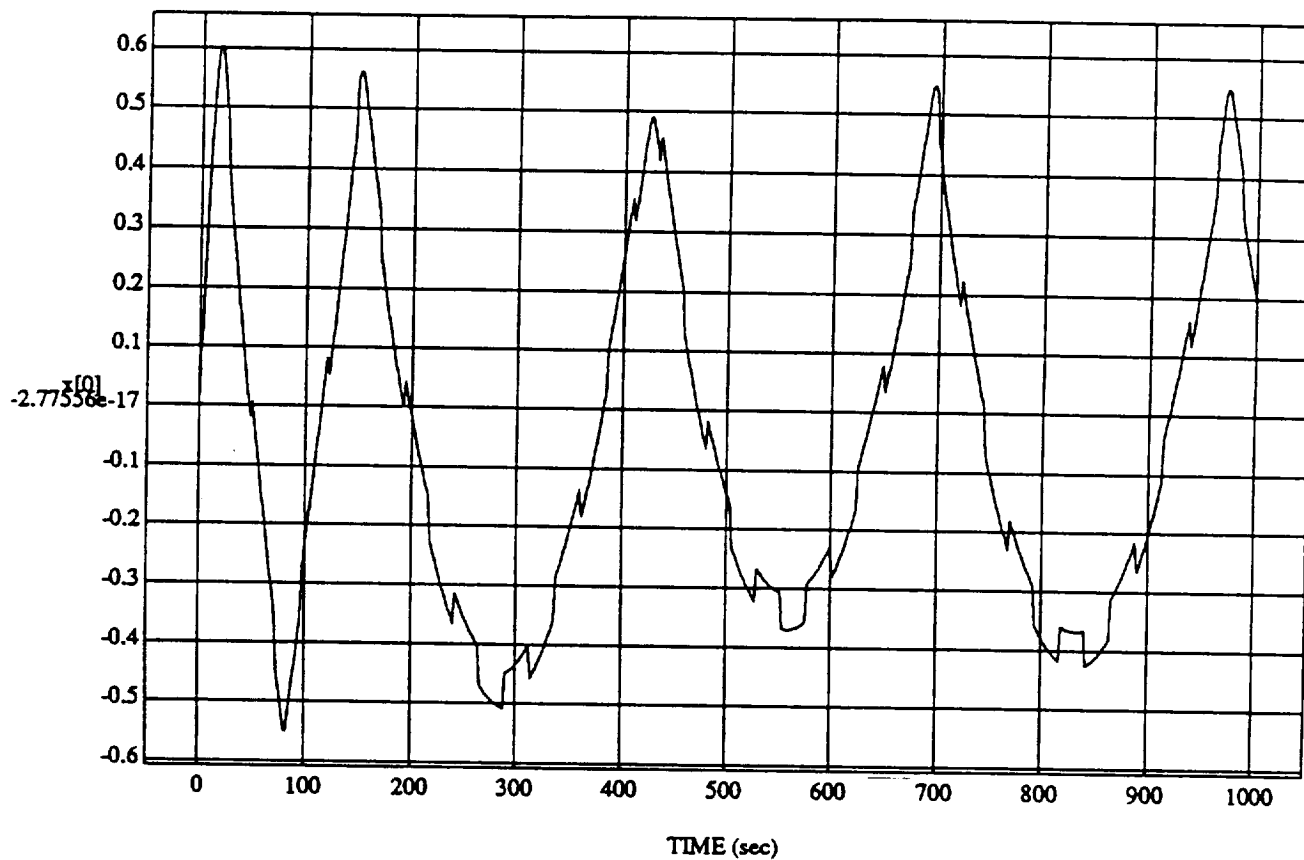
MODULE: ORB\_FUZZ\_BATCHlearn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

 $x[0]$  vs TIME

RUN: Fuzzy / NN Learner - Rnd D's &amp; Norm SUM3 - 4 May 1992

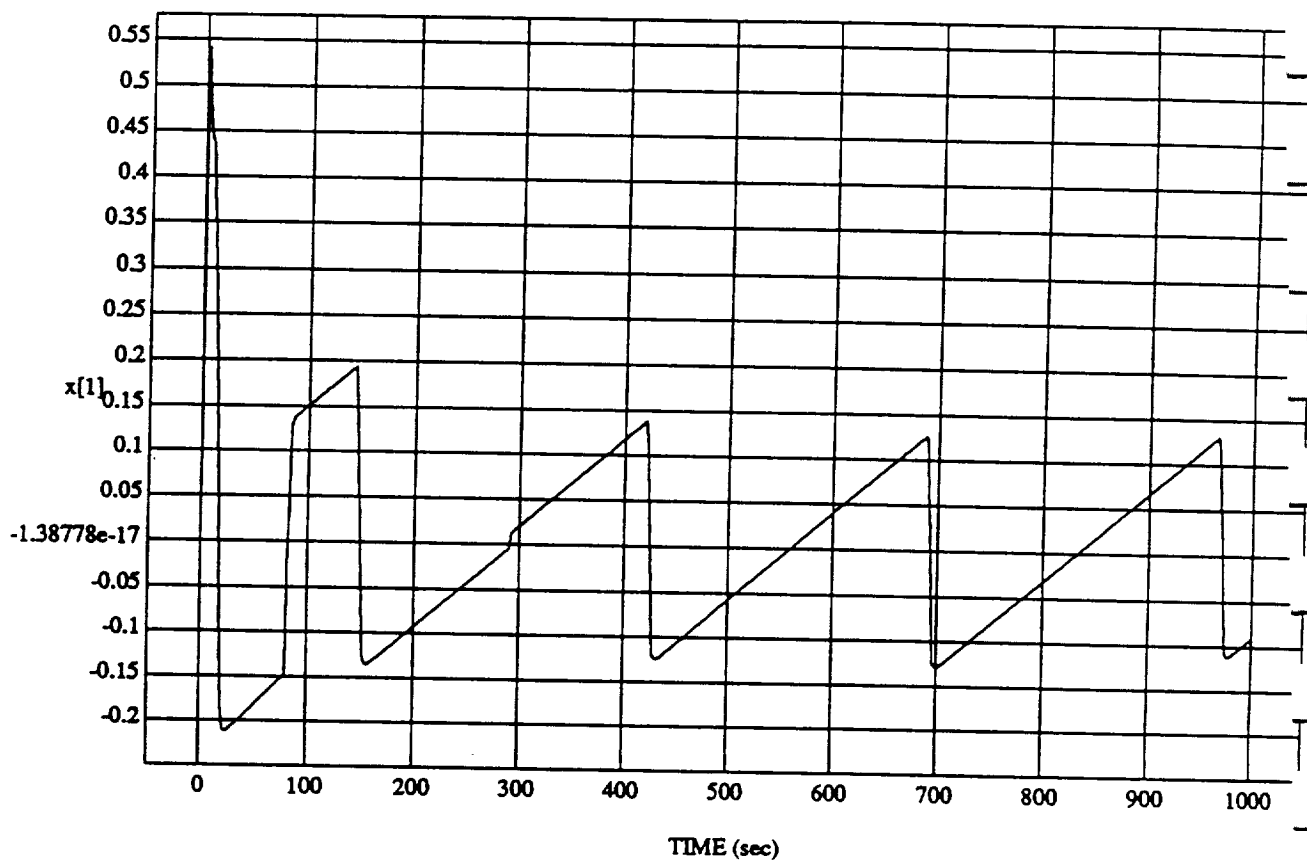


MODULE: ORB\_FUZZ\_BATCHlearn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

x[1] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's &amp; Norm SUM3 - 4 May 1992

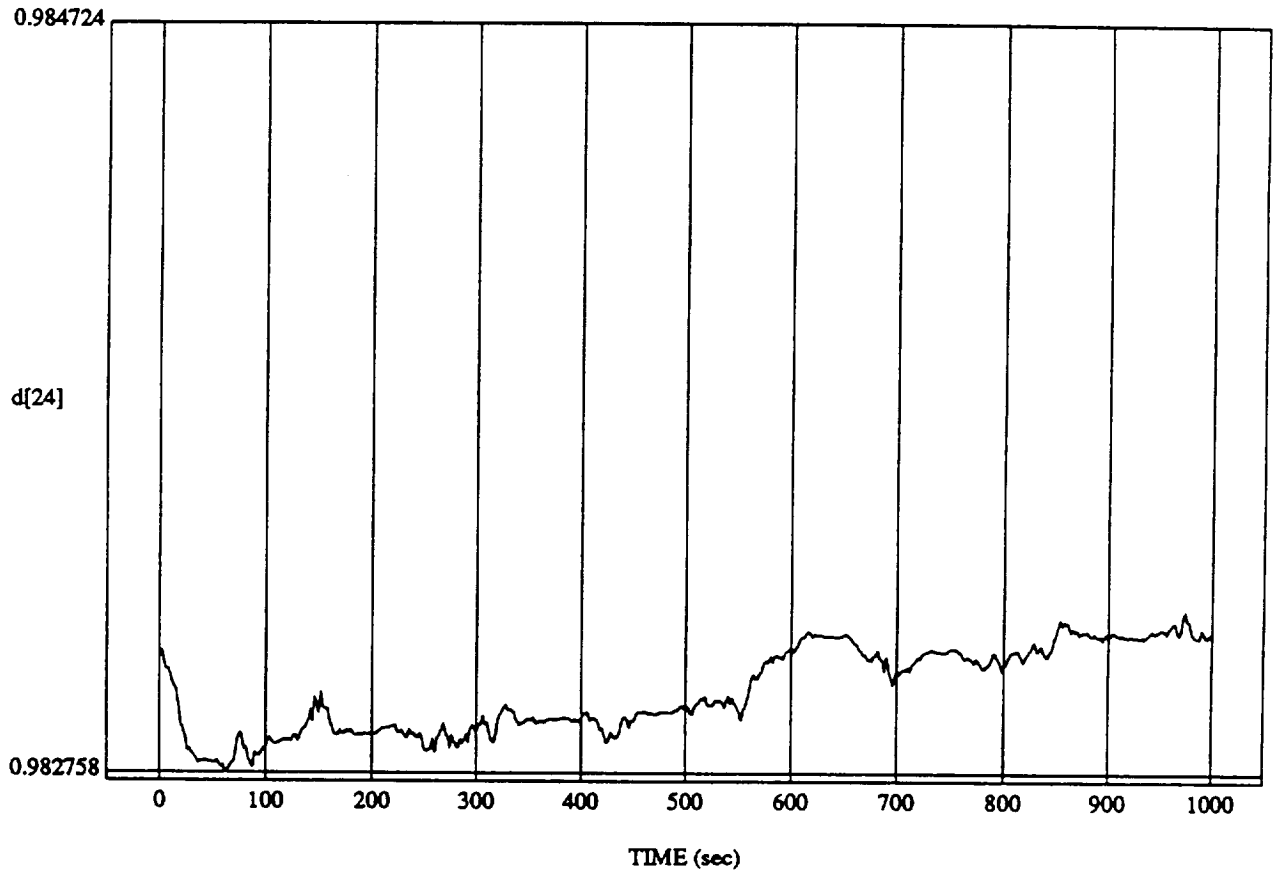


MODULE: ORB\_FUZZ\_BATCHlearn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[24] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's &amp; Norm SUM3 - 4 May 1992

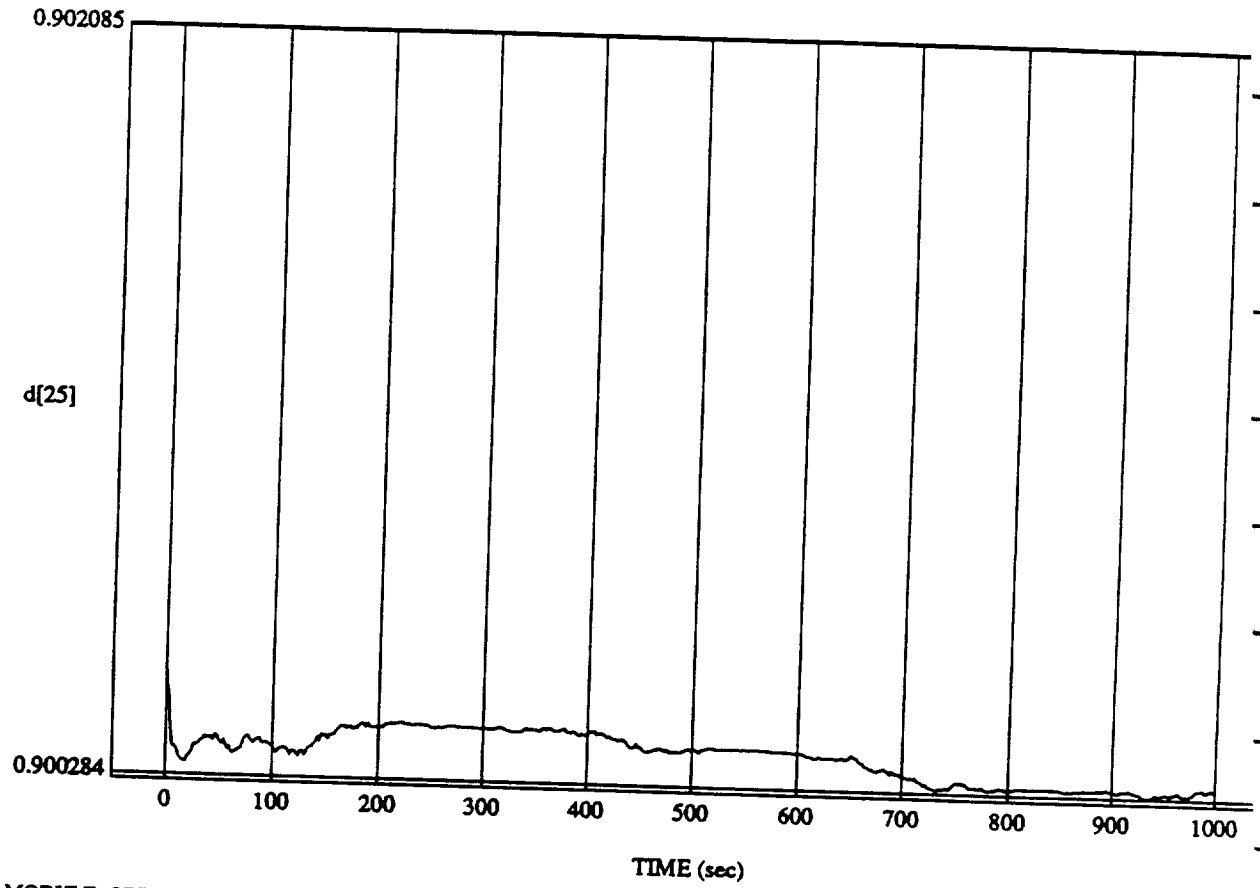


MODULE: ORB\_FUZZ\_BATCHlearn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[25] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

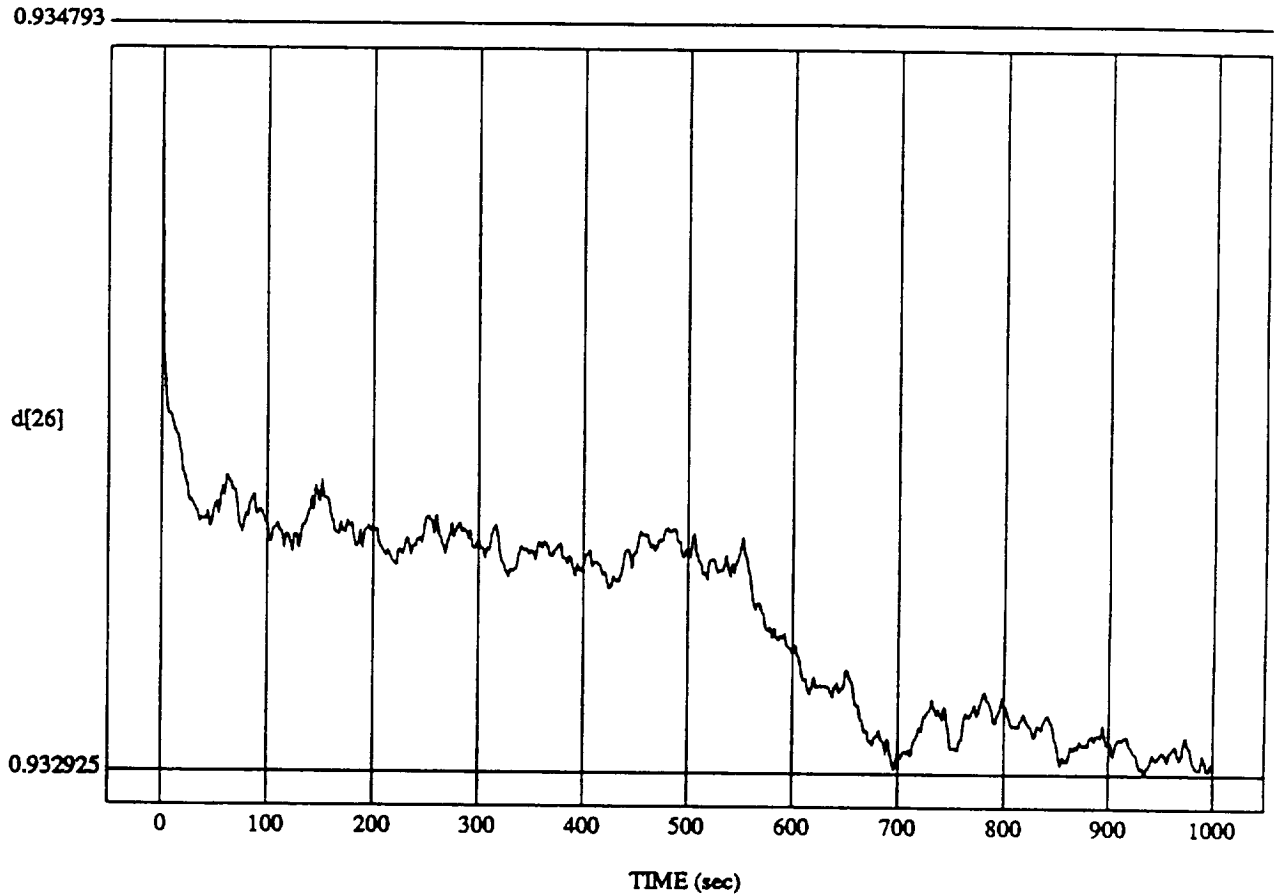


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[26] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's &amp; Norm SUM3 - 4 May 1992



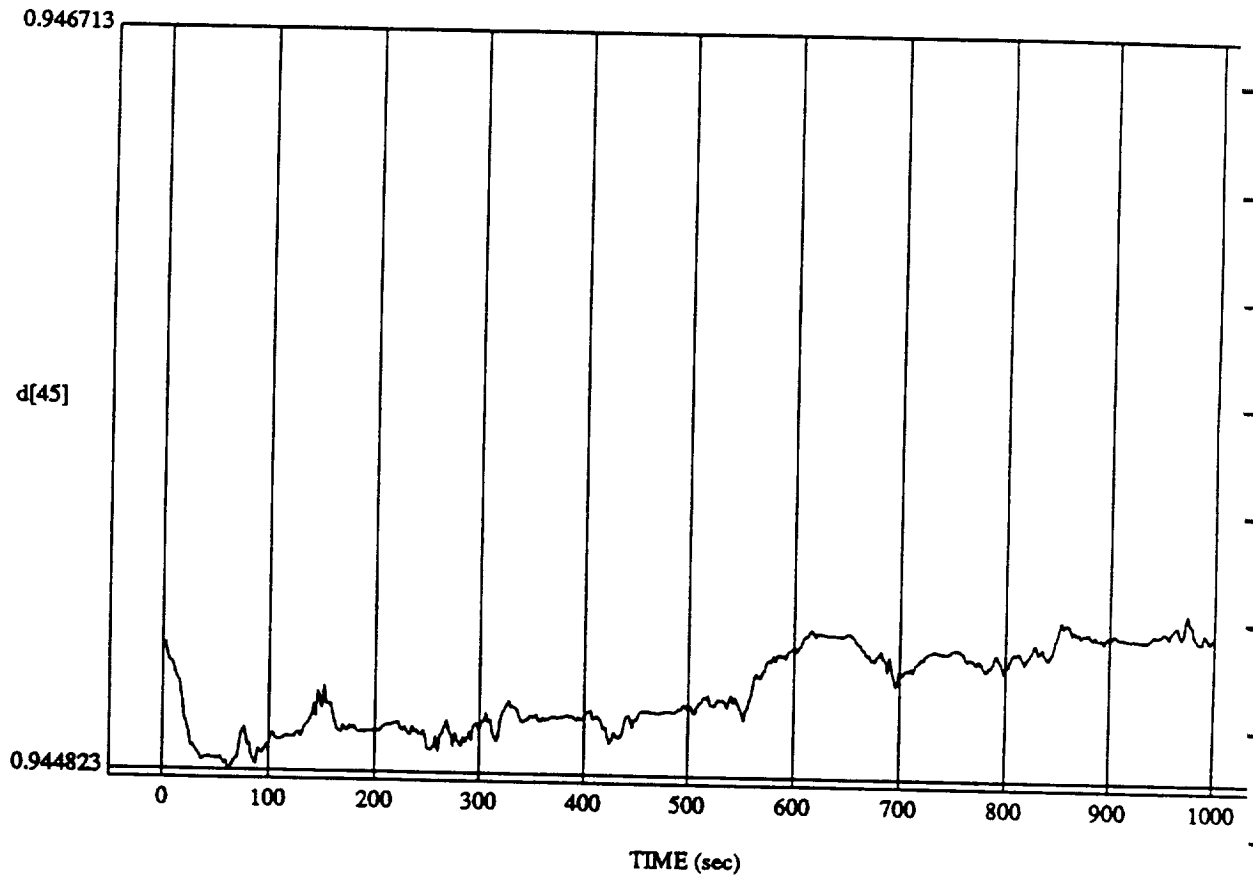
MODULE: ORB\_FUZZ\_BATCH.learm2

DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[45] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



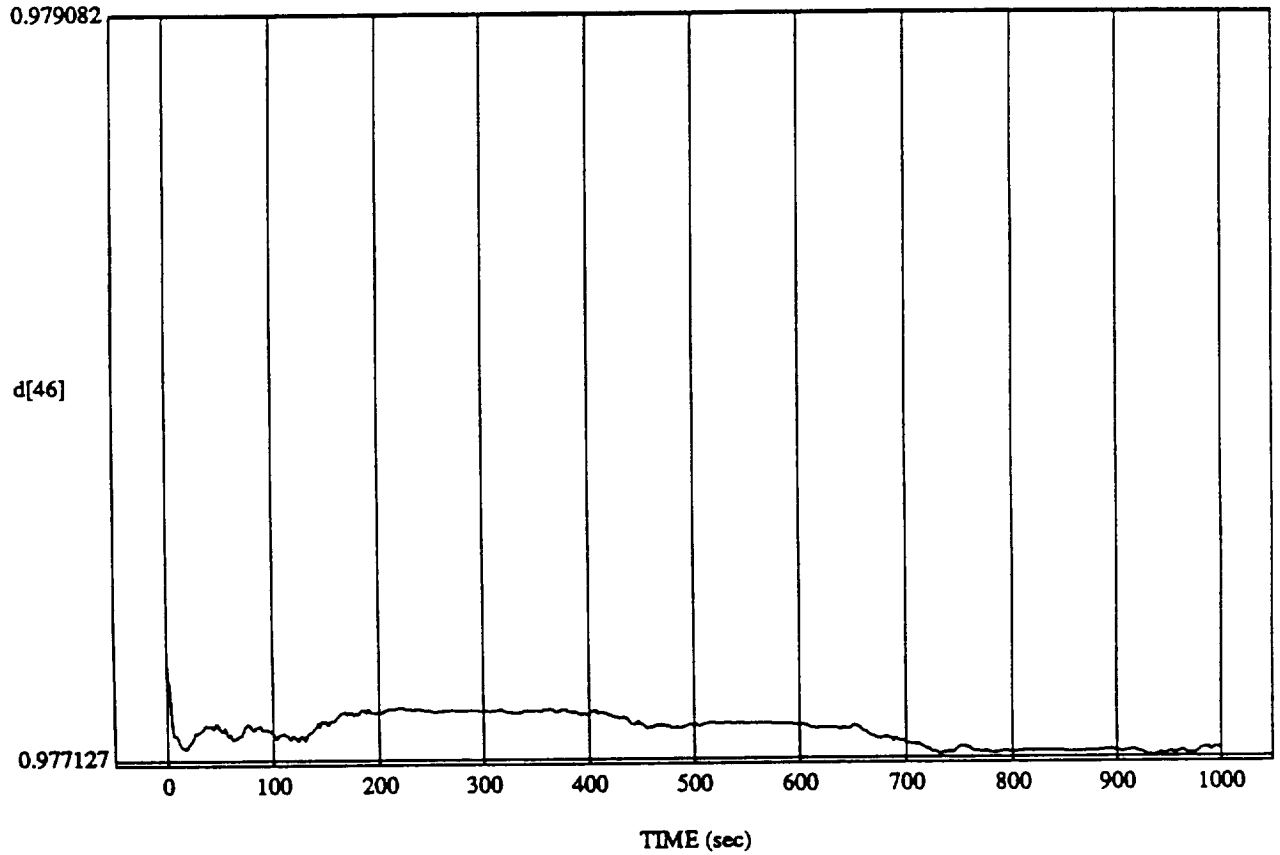
MODULE: ORB\_FUZZ\_BATCHlearn2

DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[46] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

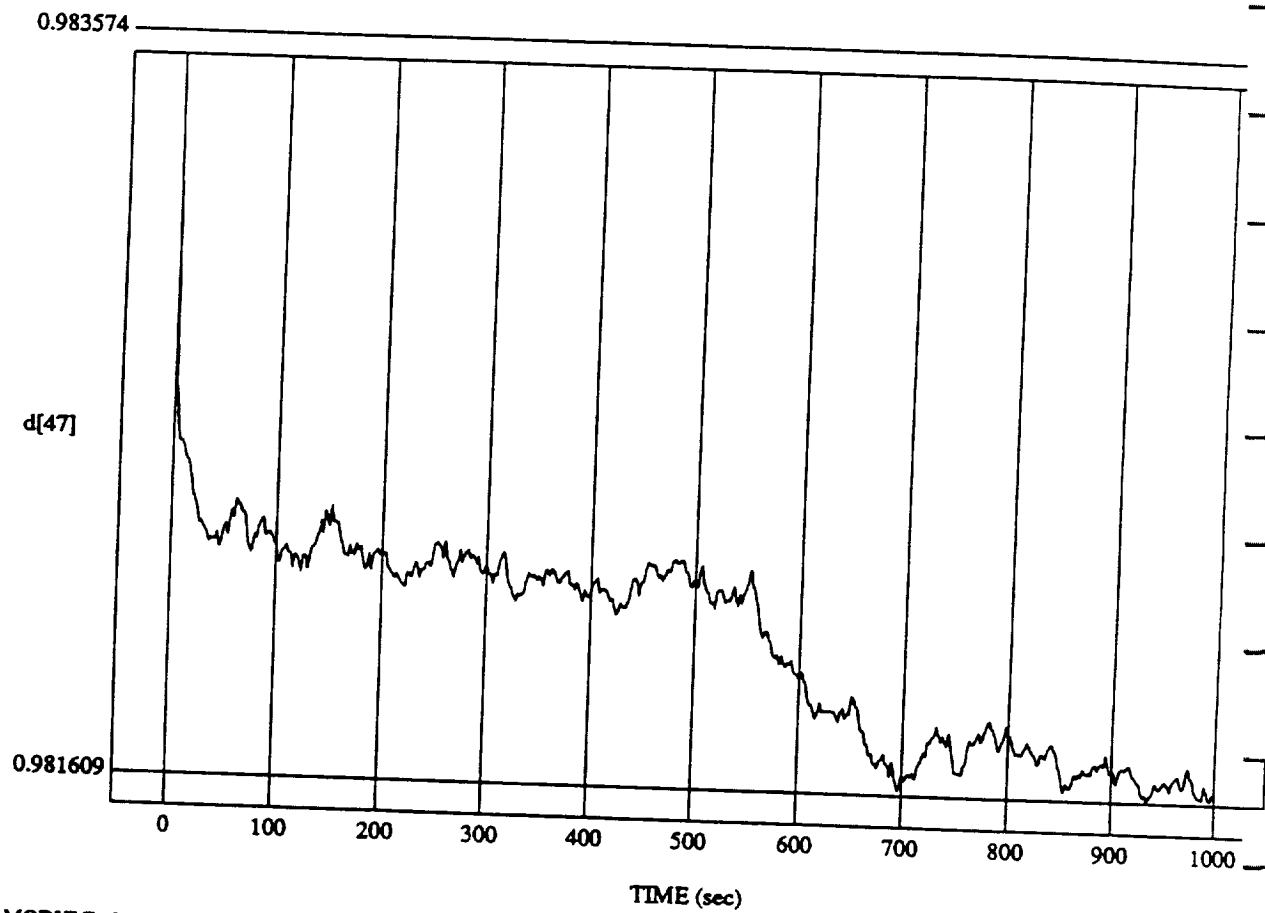


MODULE: ORB\_FUZZ\_BATCHlearn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[47] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



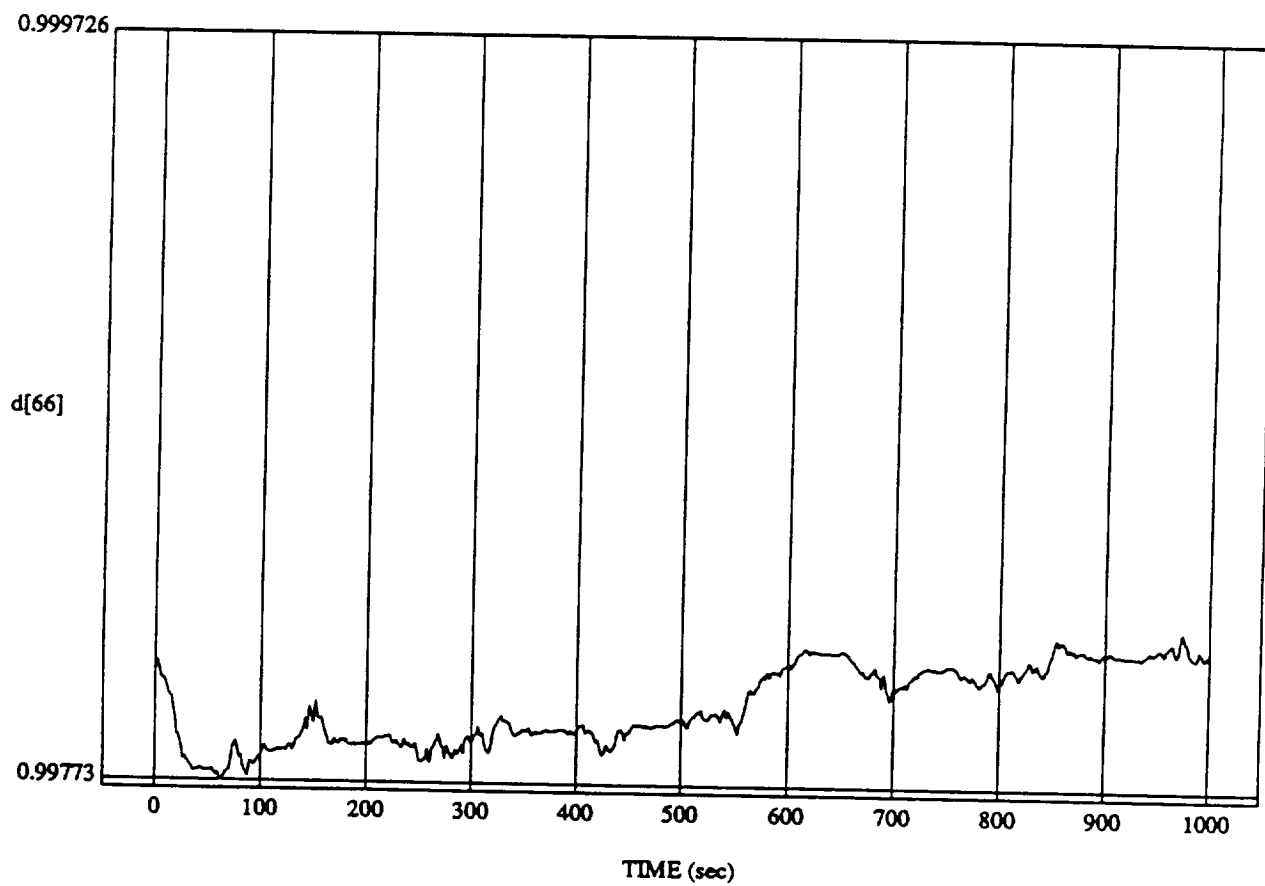
MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[66] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

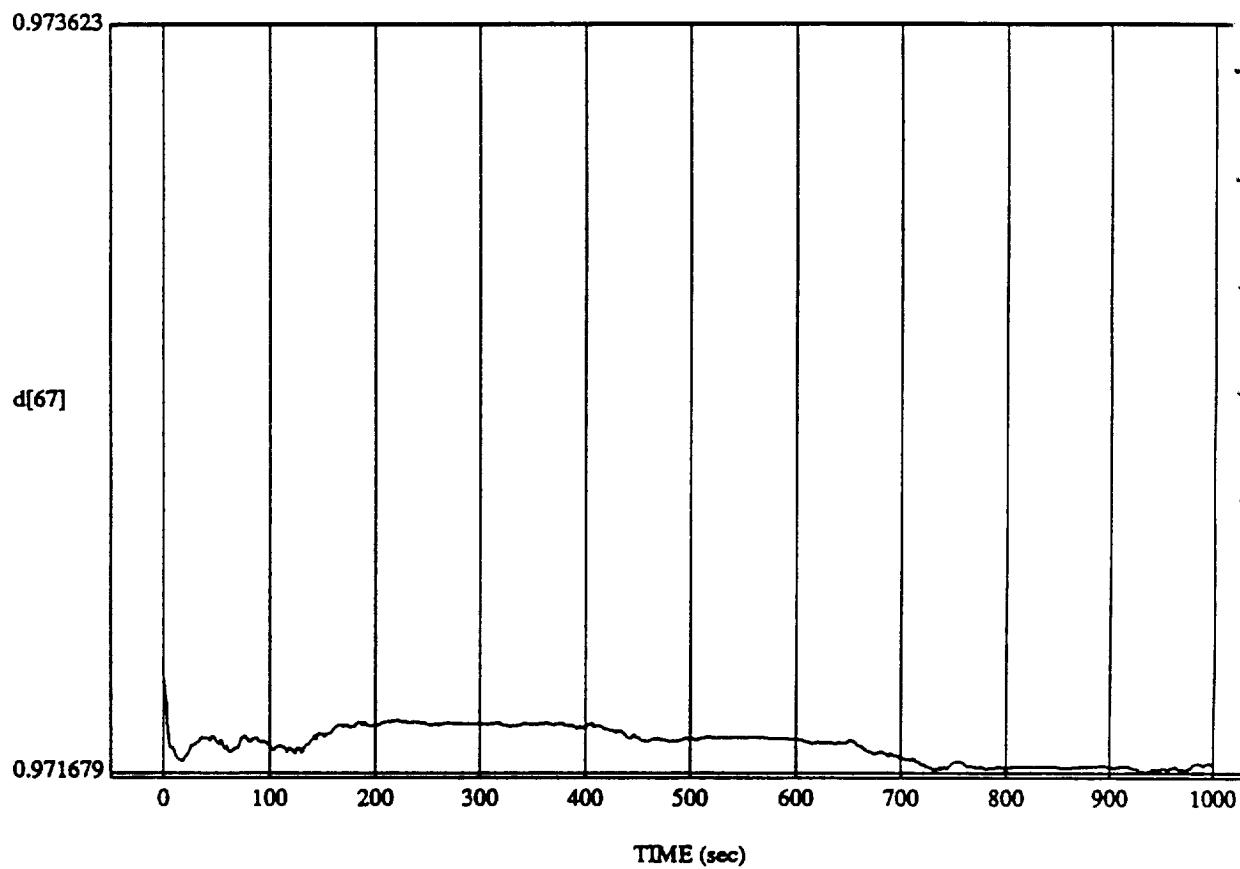


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[67] vs TIME

RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

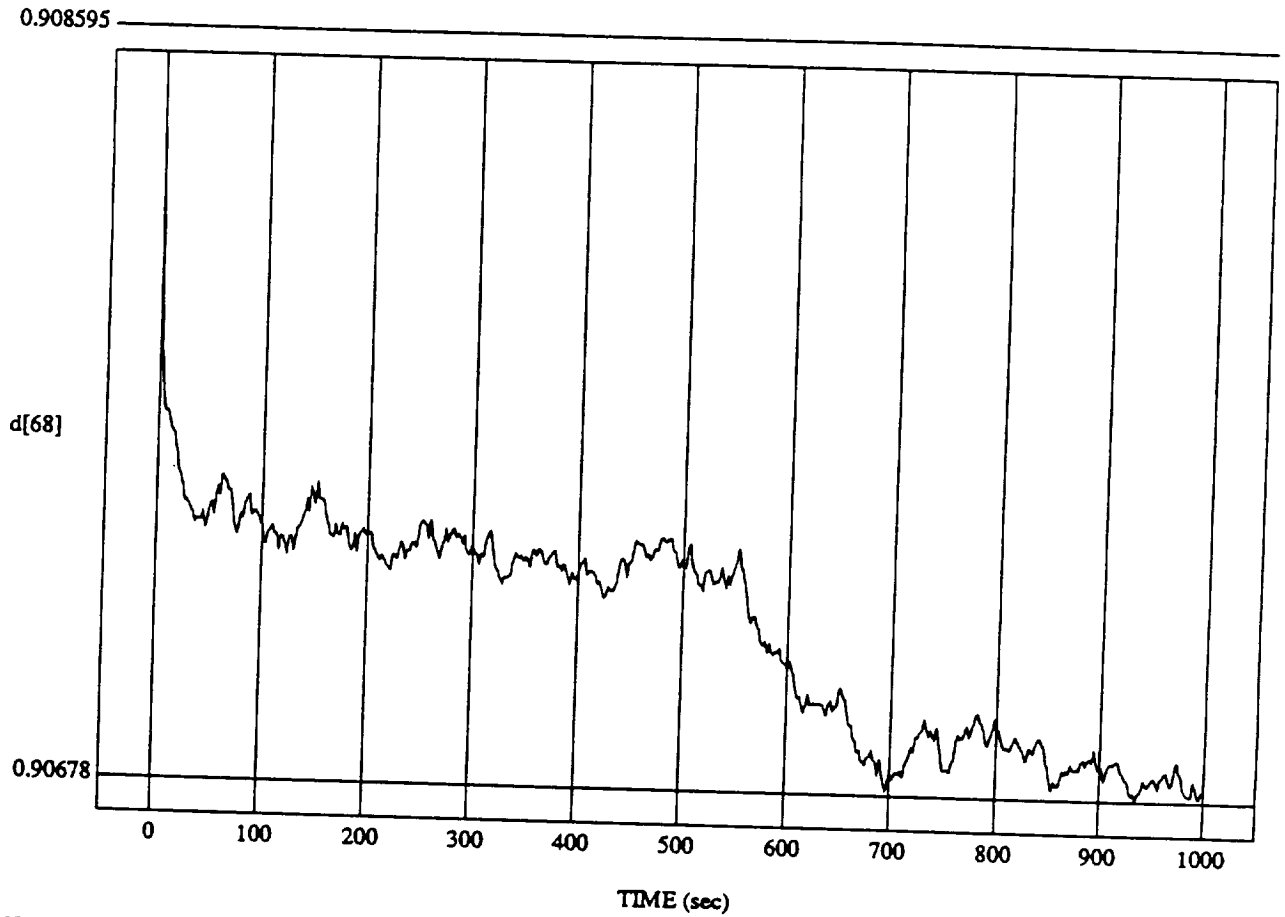


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[68] vs TIME

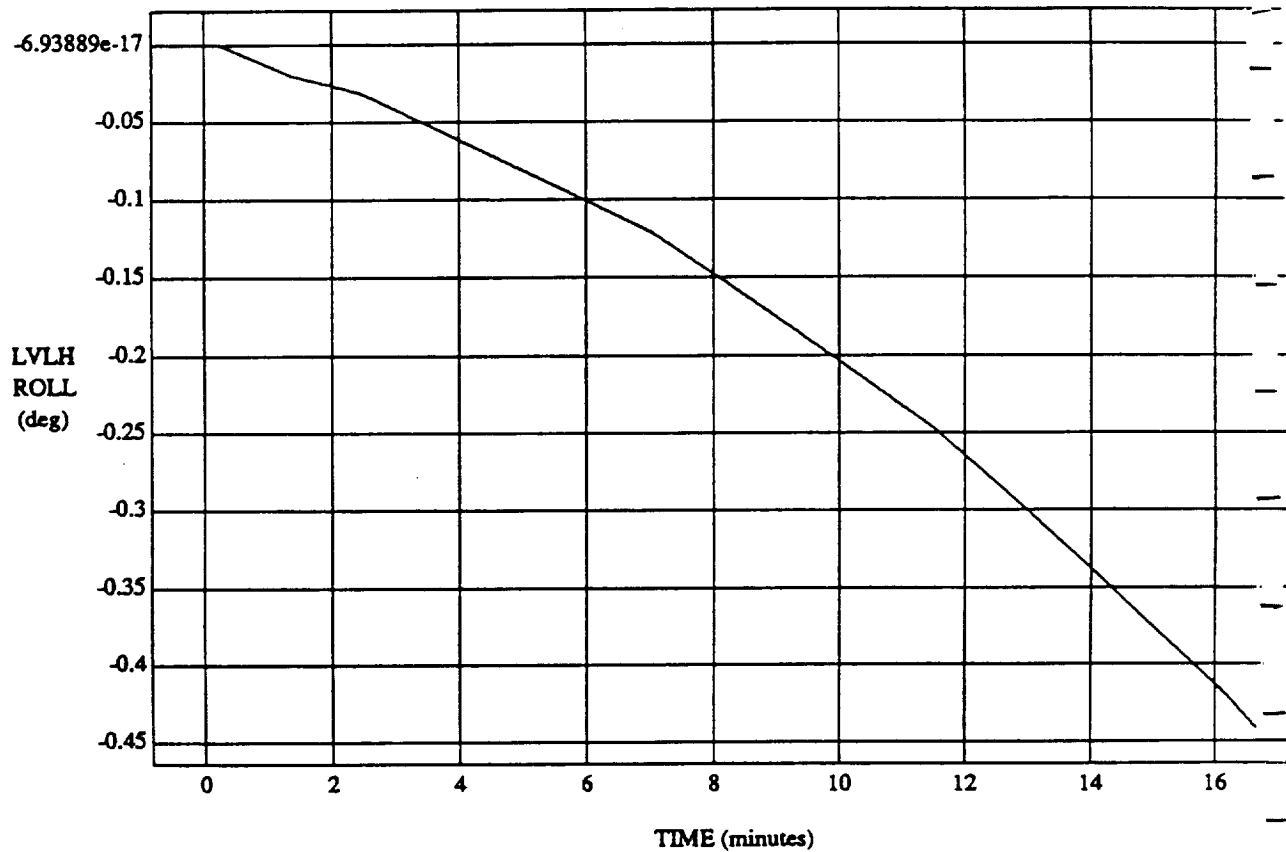
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

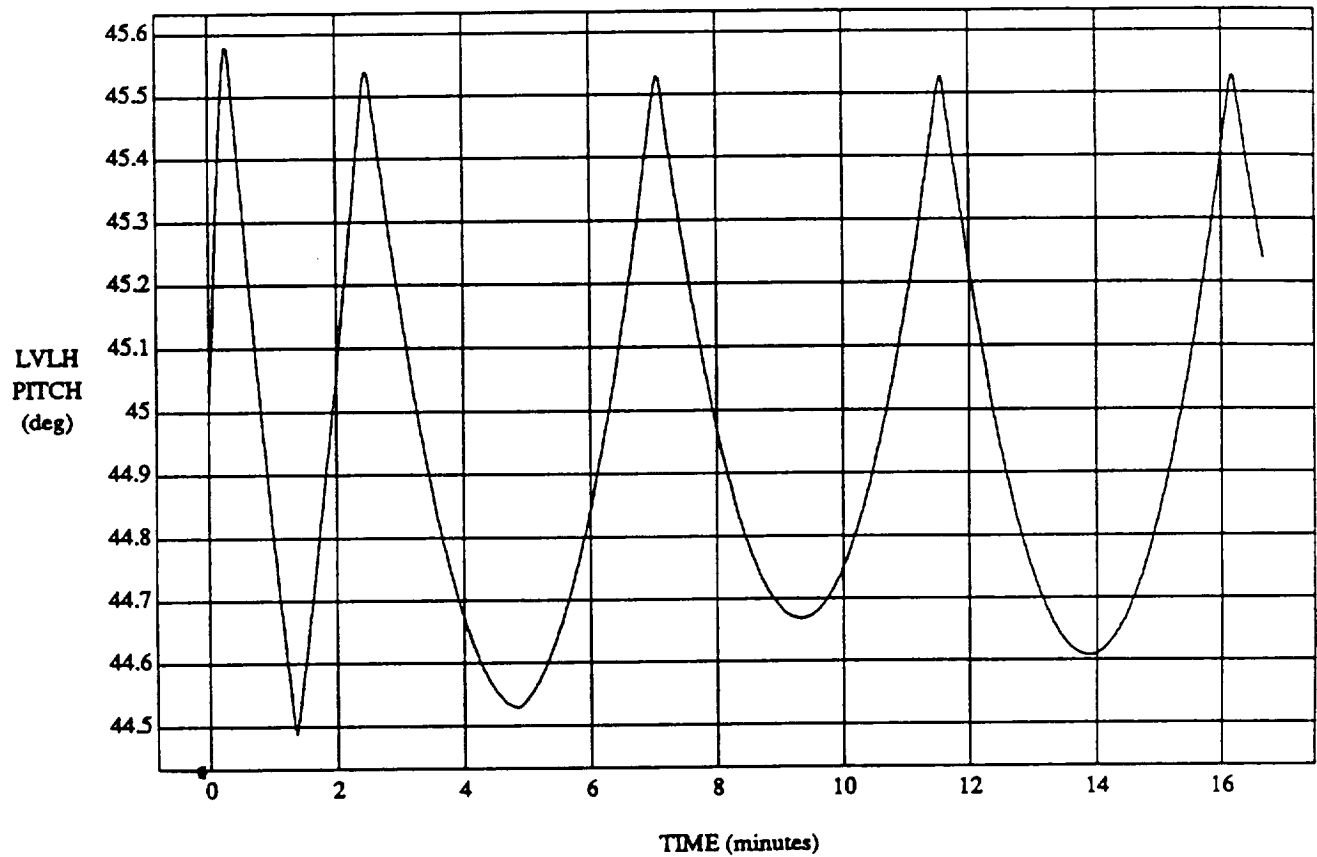
LVLH EULER PYR ROLL vs TIME  
 RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
 DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

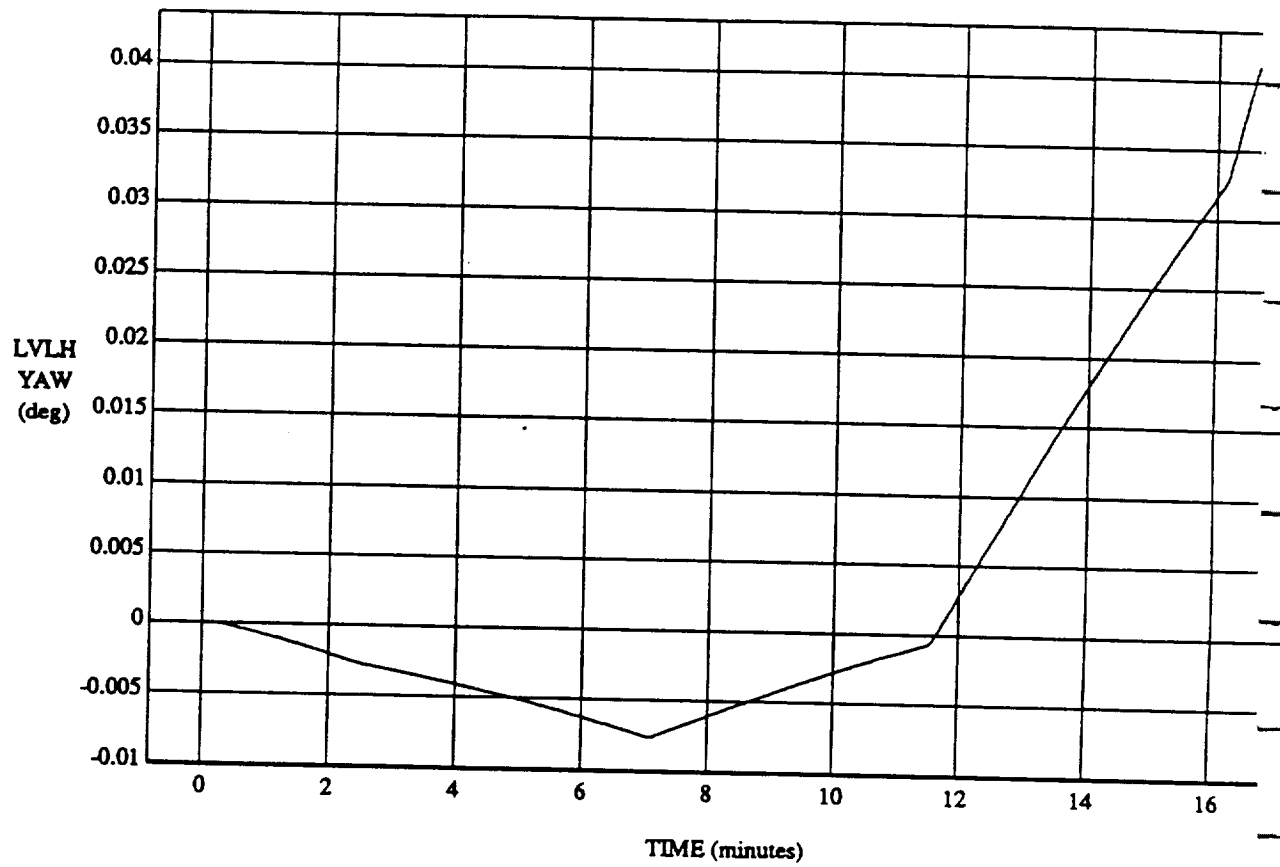
LVLH EULER PYR PITCH vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

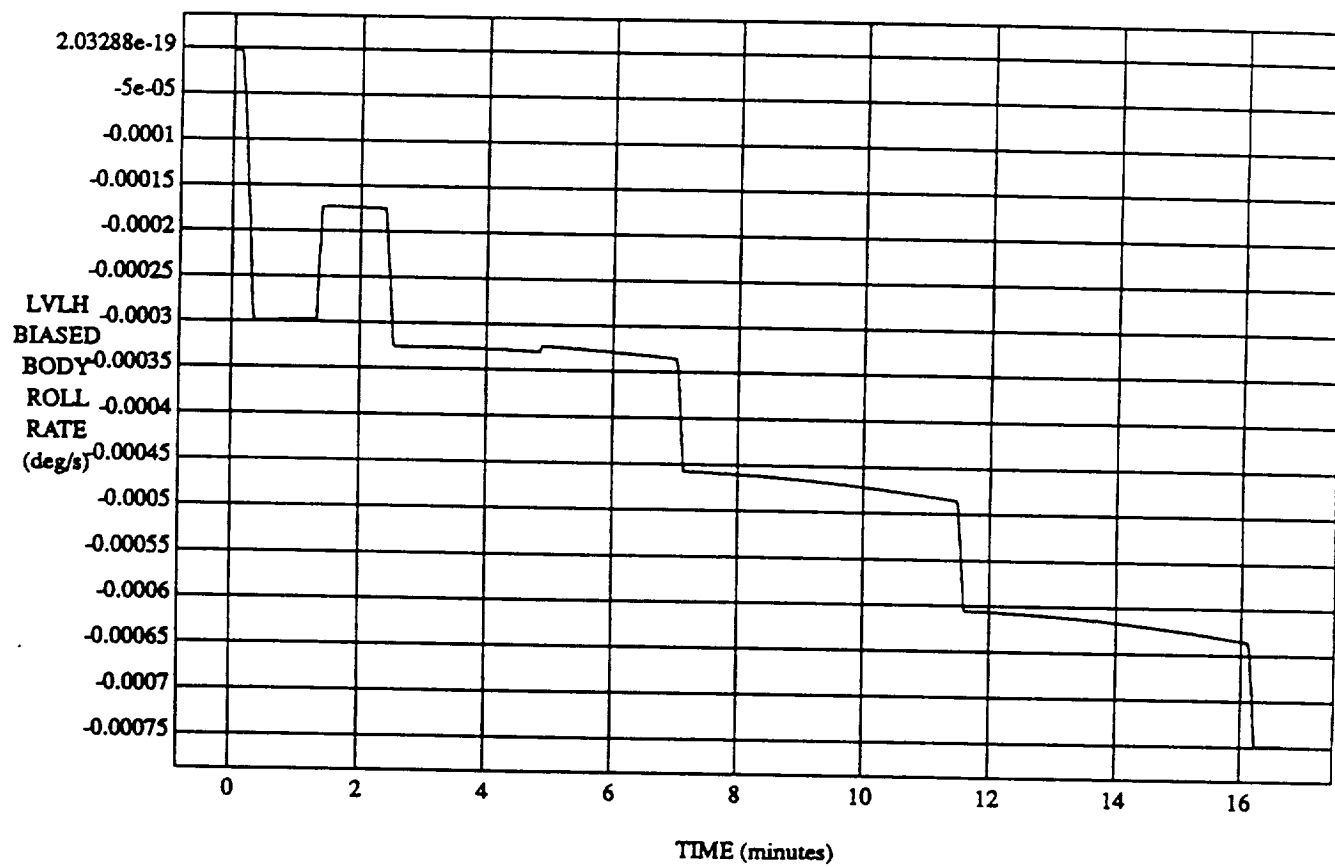
SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH EULER PYR YAW vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

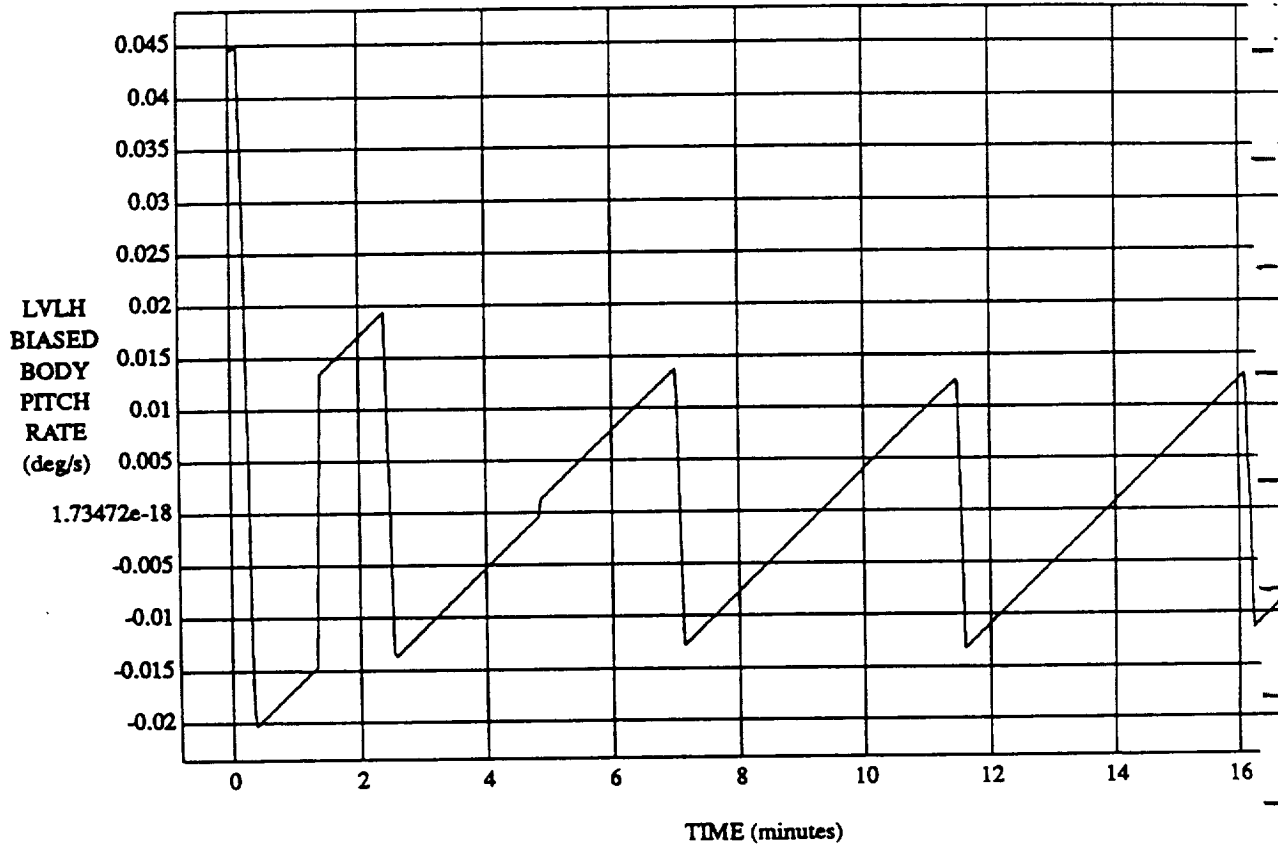
LVLH BIASED BODY ROLL RATE vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH BIASED BODY PITCH RATE vs TIME

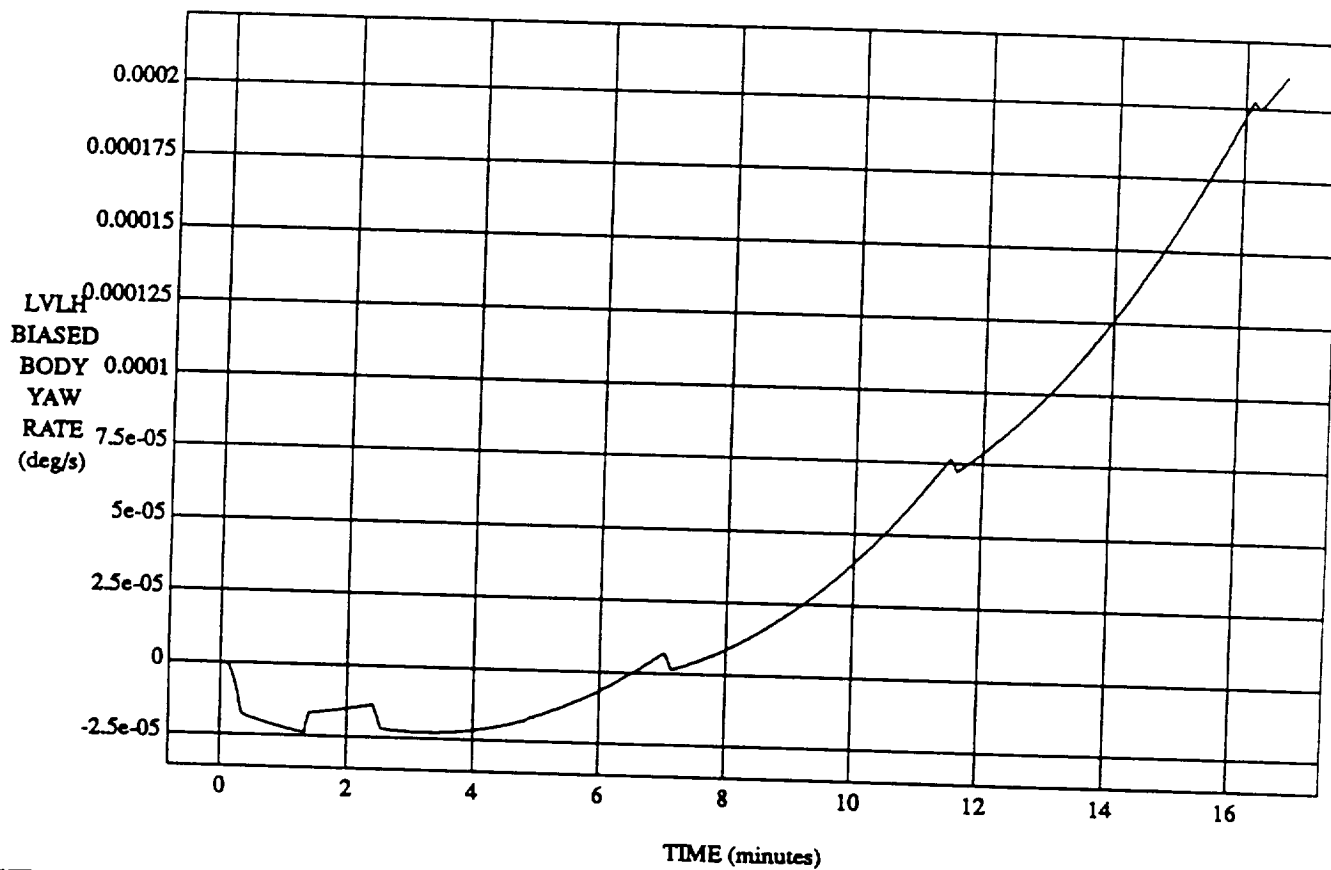
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz



## SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH BIASED BODY YAW RATE vs TIME  
RUN: Fuzzy / NN Learner - Rnd D's & Norm SUM3 - 4 May 1992

VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz



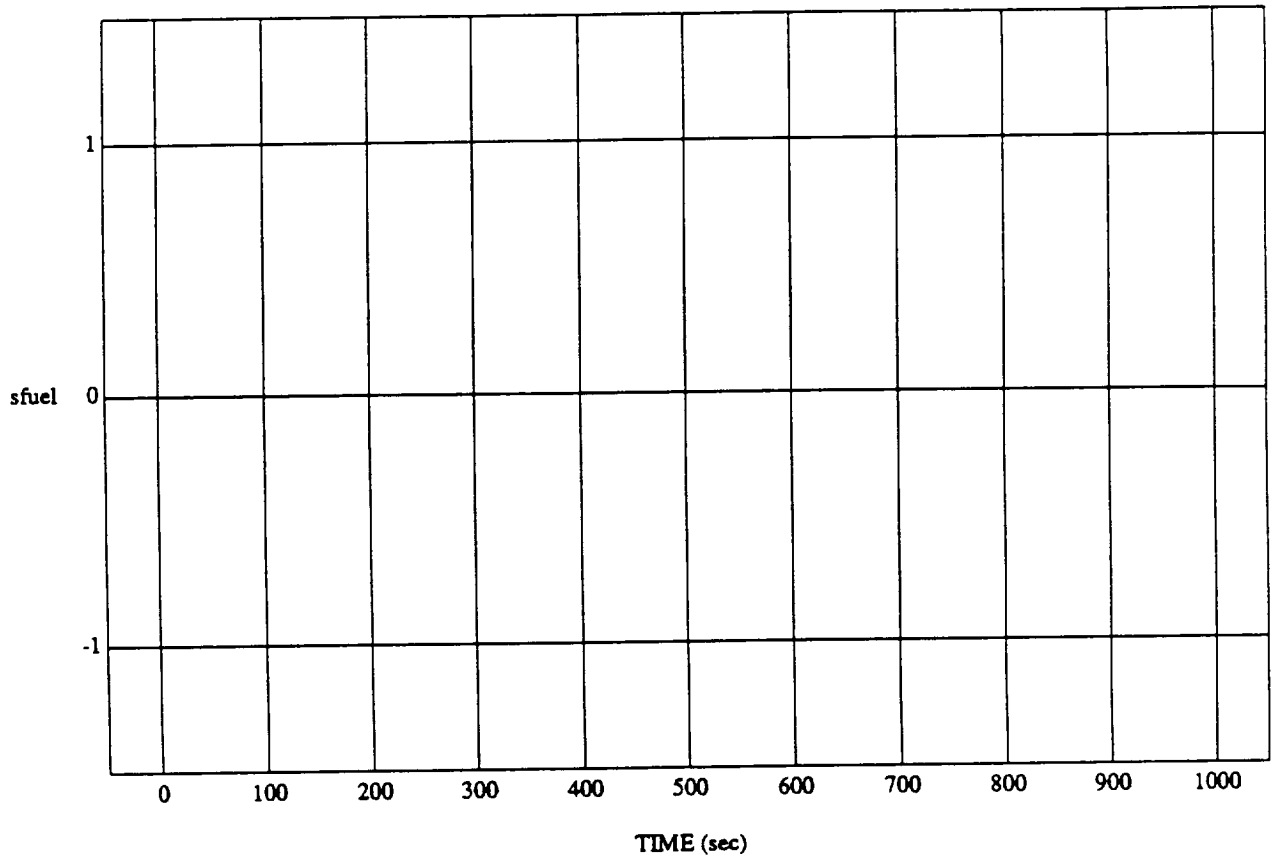




VII

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 23 June 1992

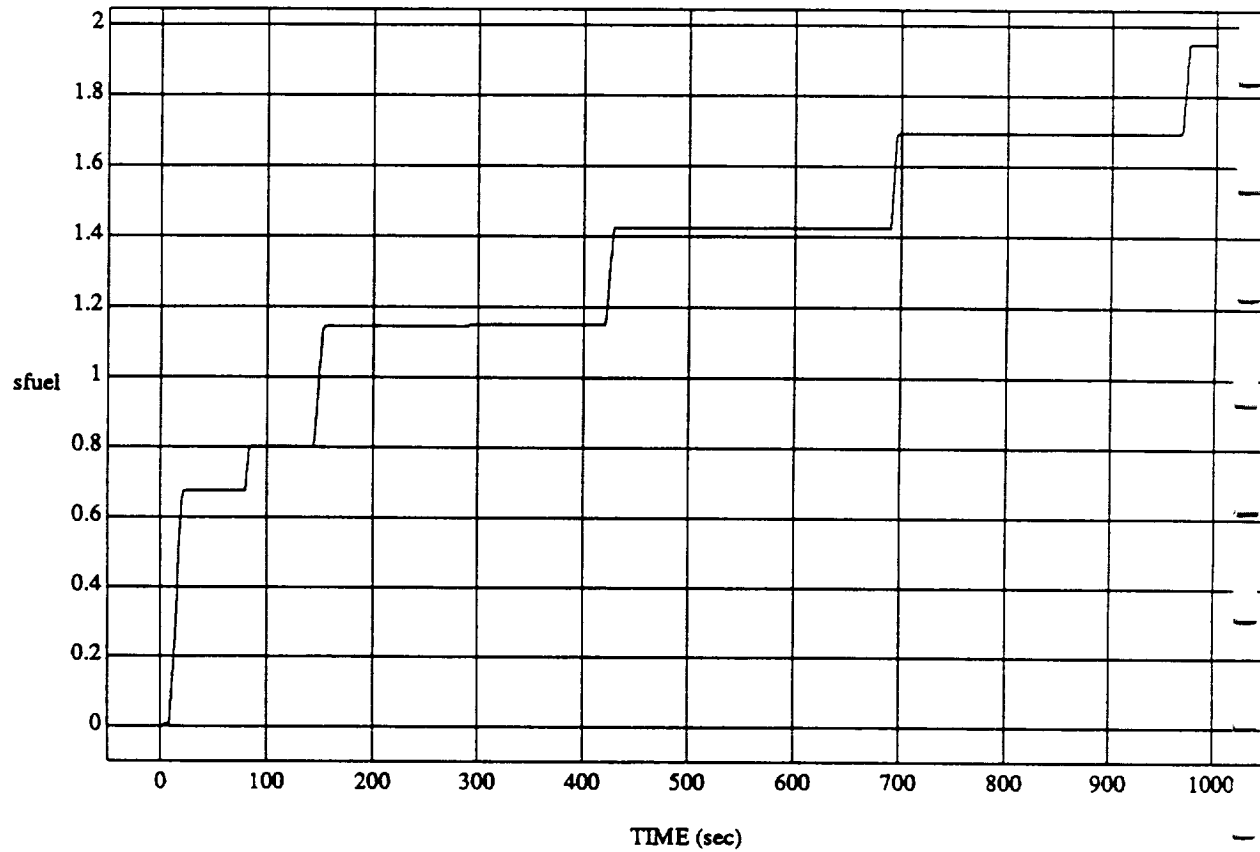


MODULE: ORB\_FUZZ\_BATCH.primary  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

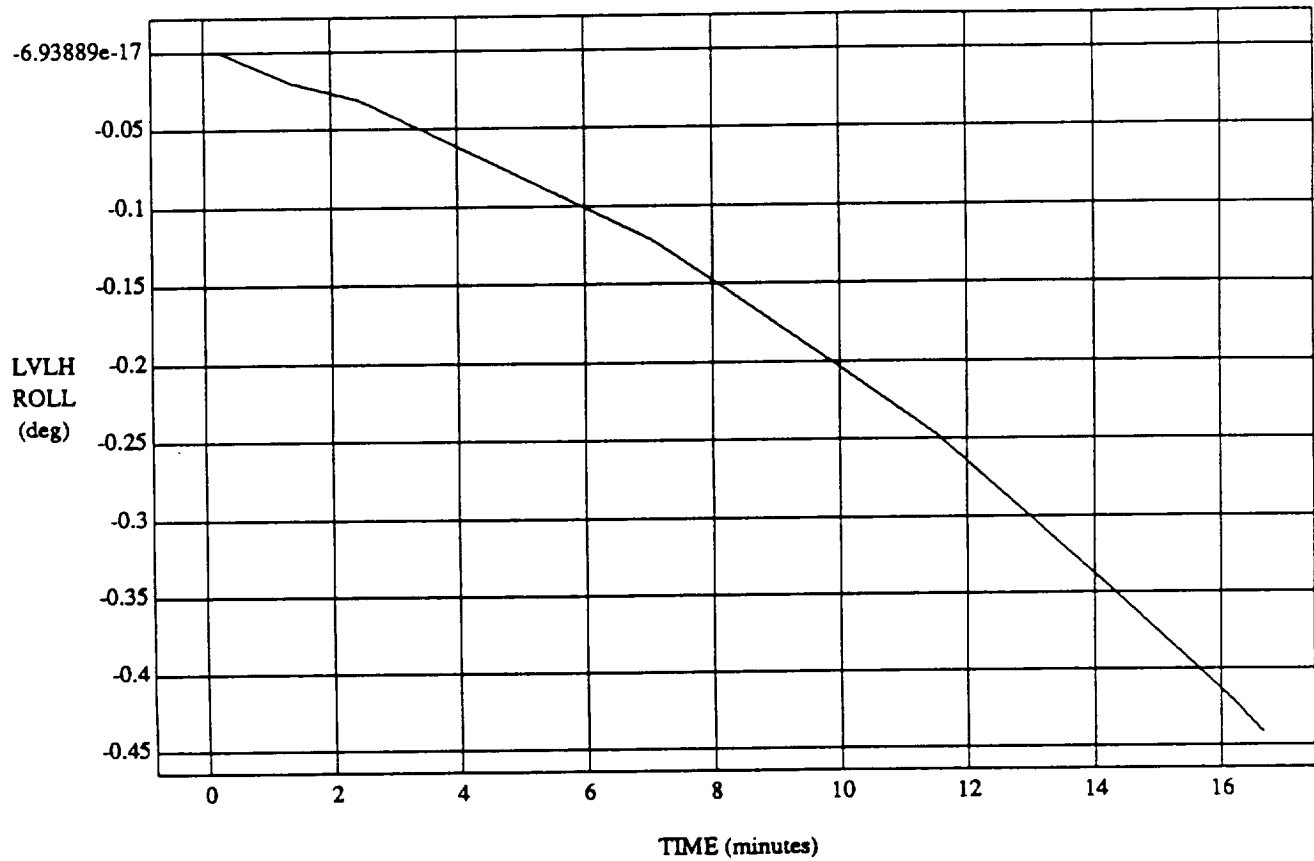


MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

# LVLH EULER PYR ROLL vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

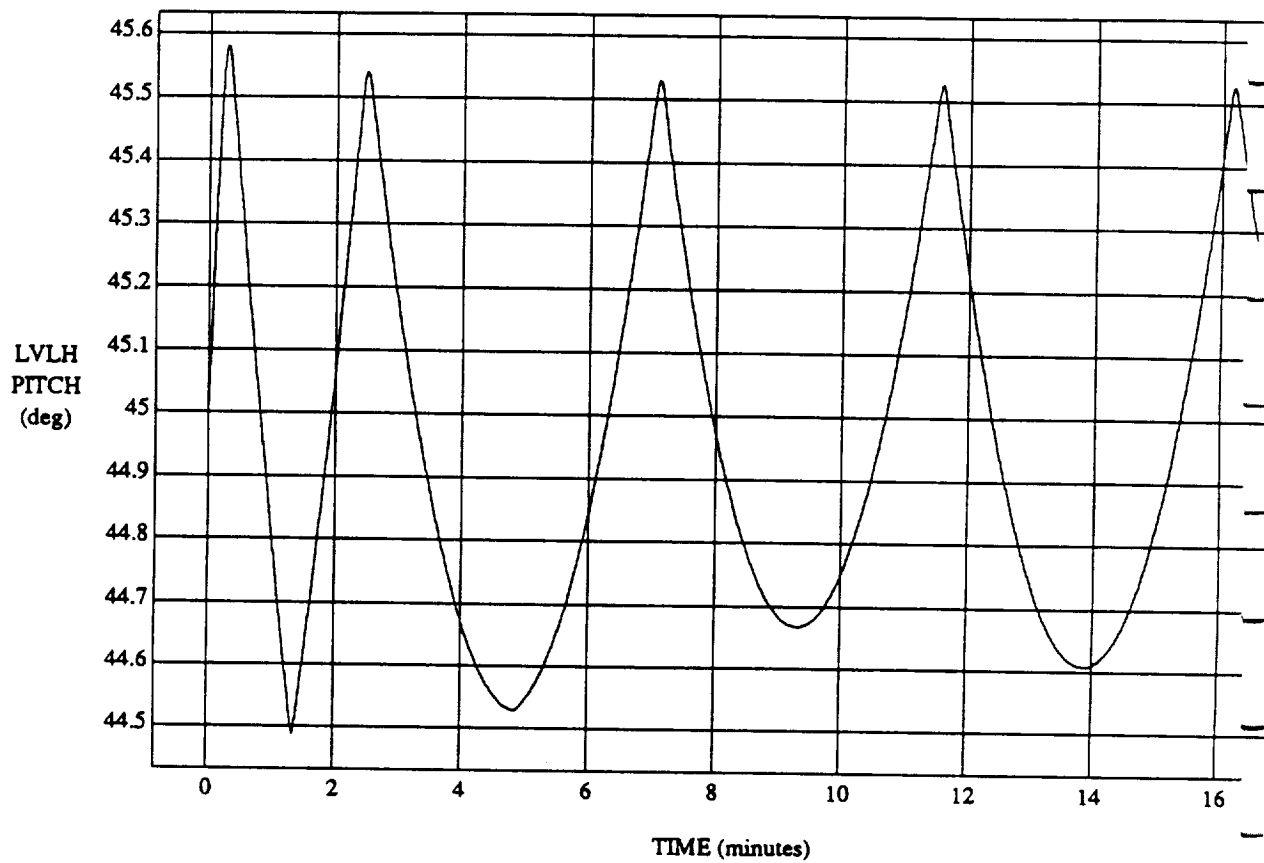


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

# LVLH EULER PYR PITCH vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



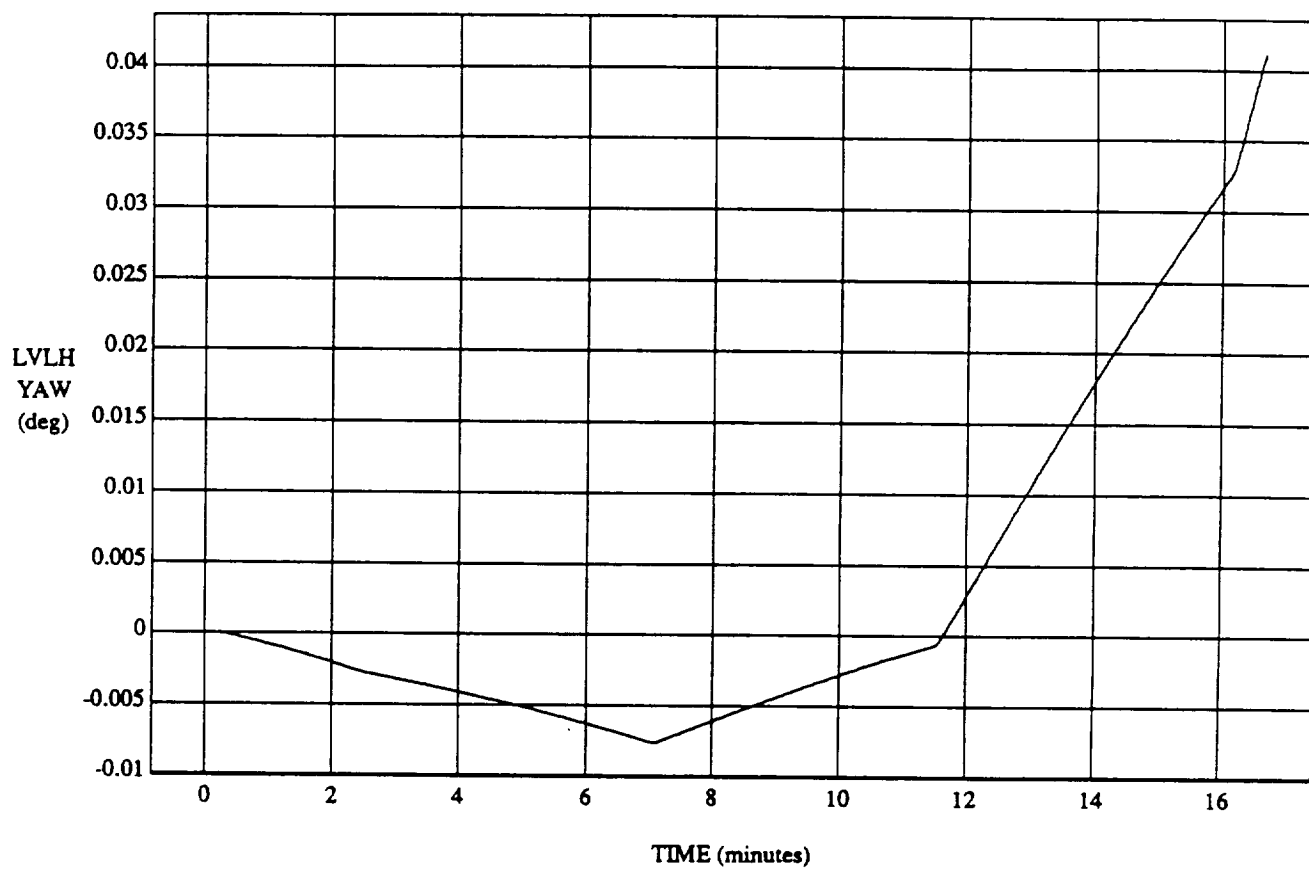
VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

# LVLH EULER PYR YAW vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

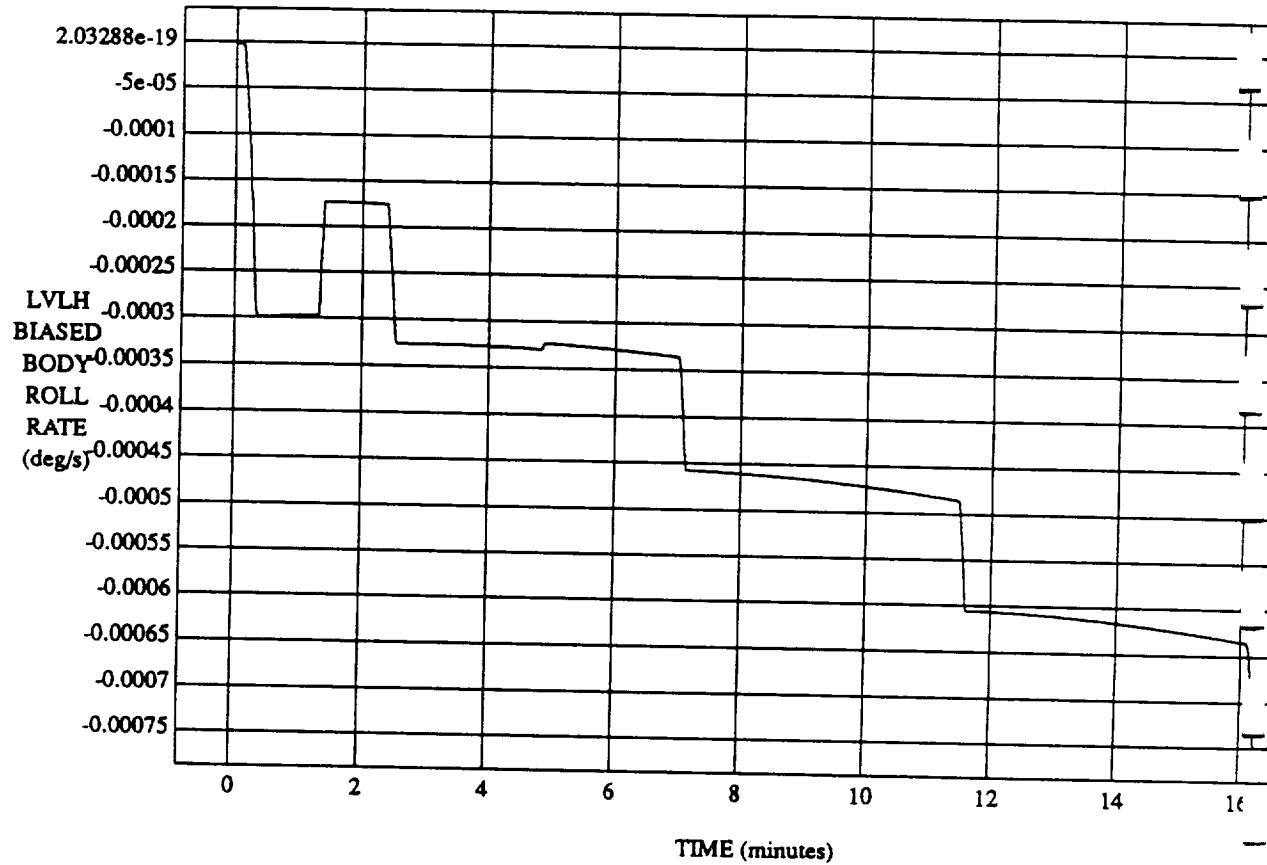


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

# LVLH BIASED BODY ROLL RATE vs TIME

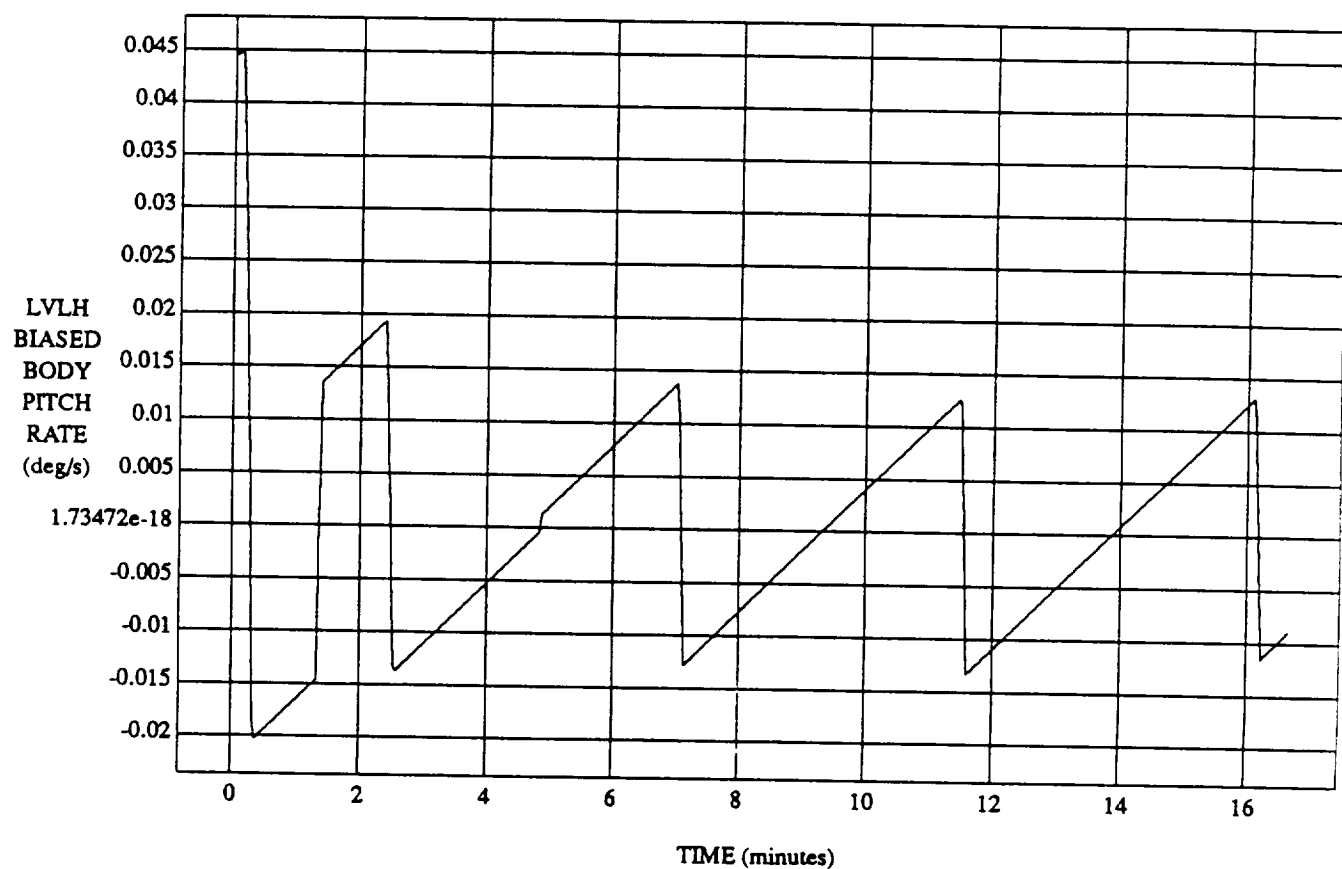
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

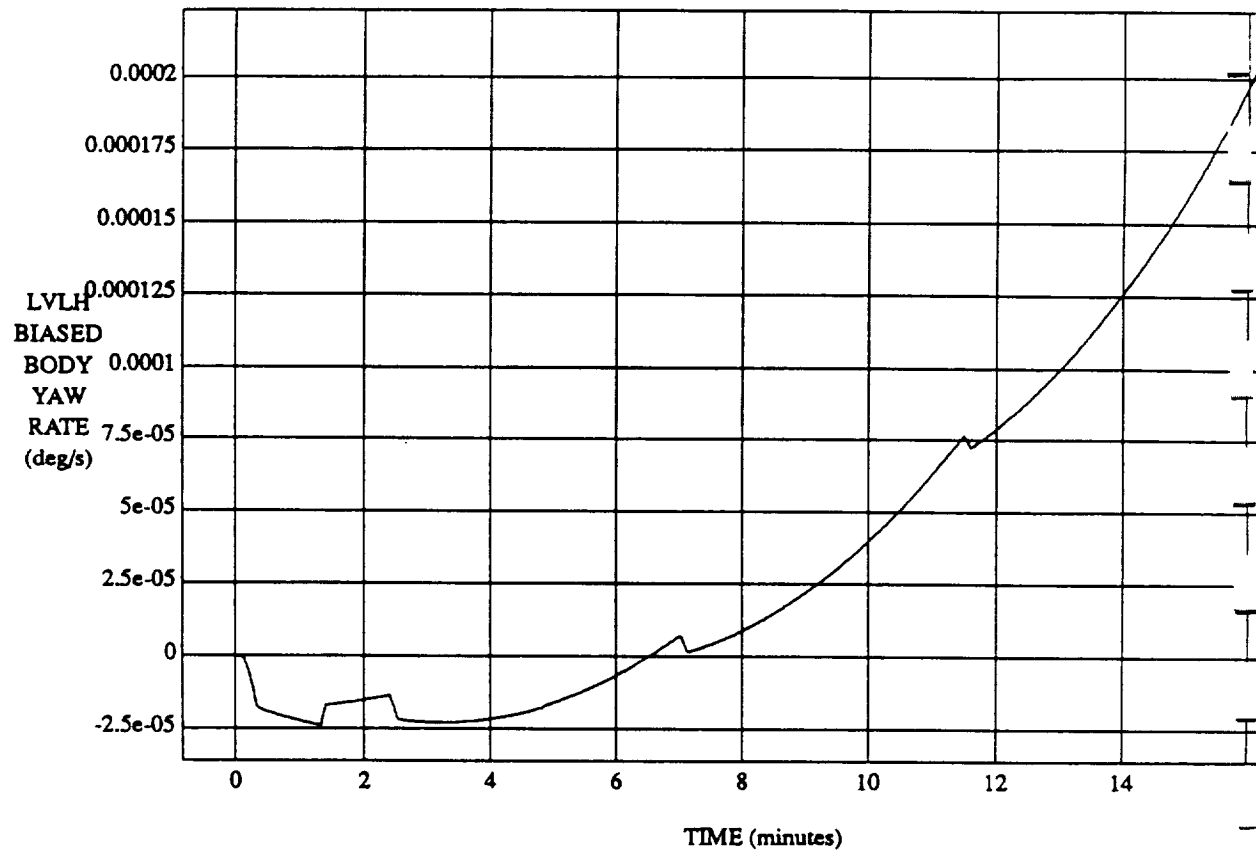
LVLH BIASED BODY PITCH RATE vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH BIASED BODY YAW RATE vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

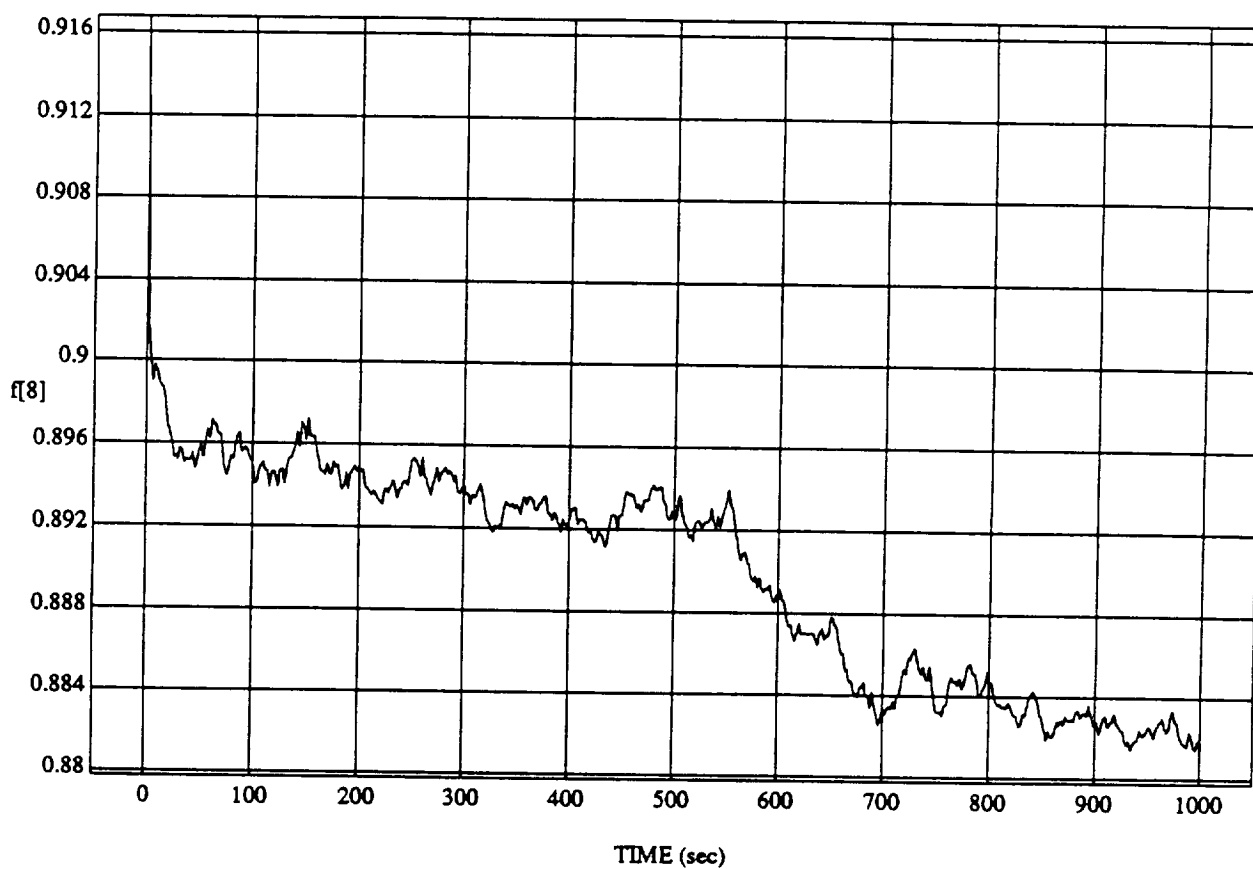


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[8]$  vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

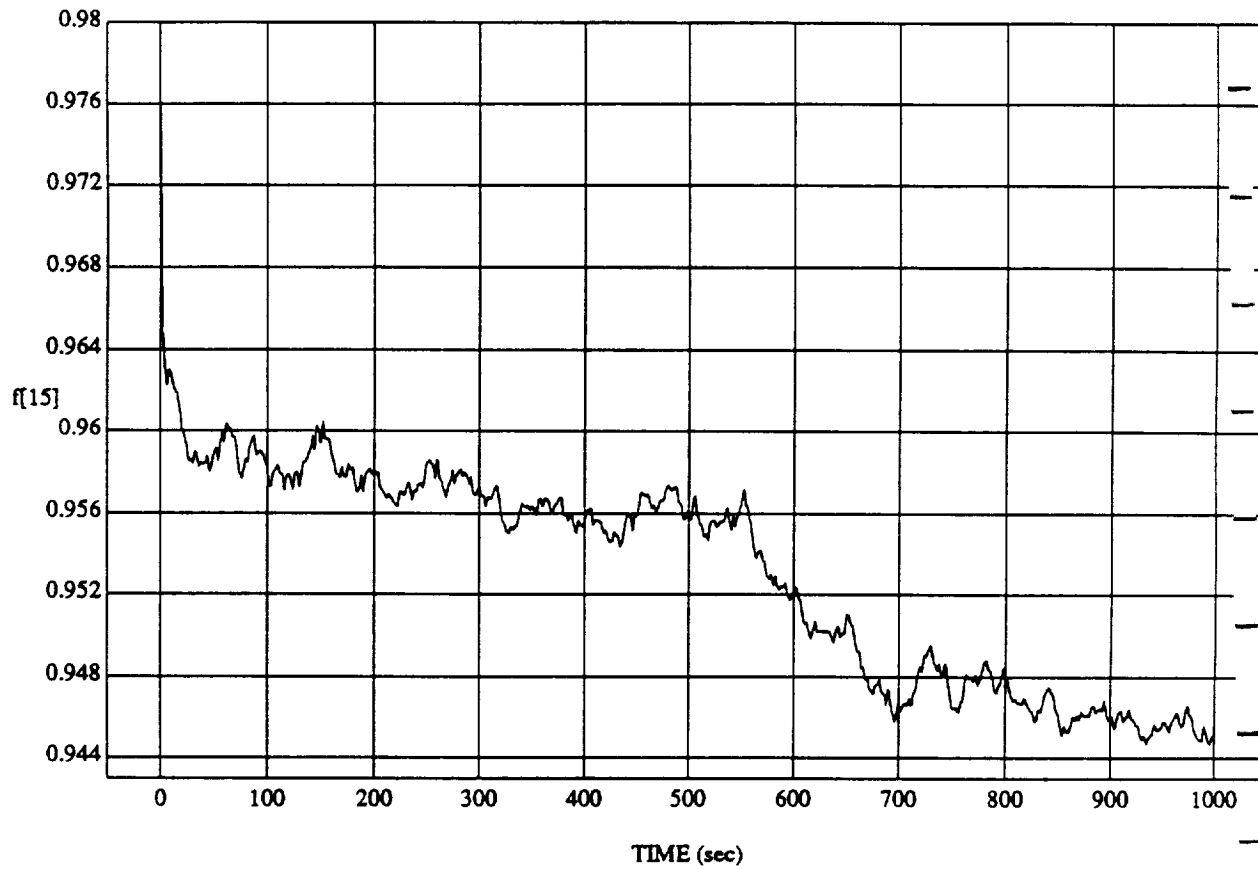


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[15] vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

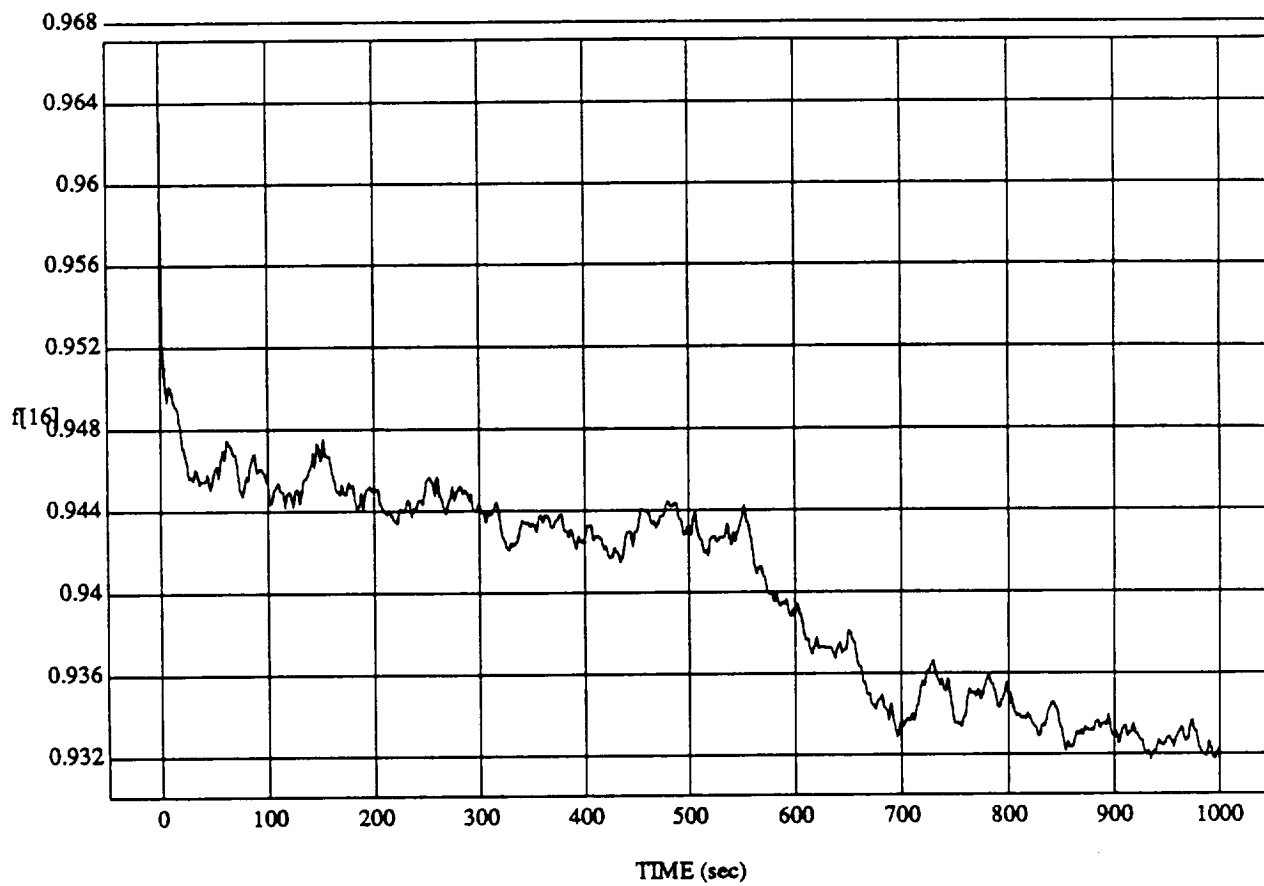


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[16]$  vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

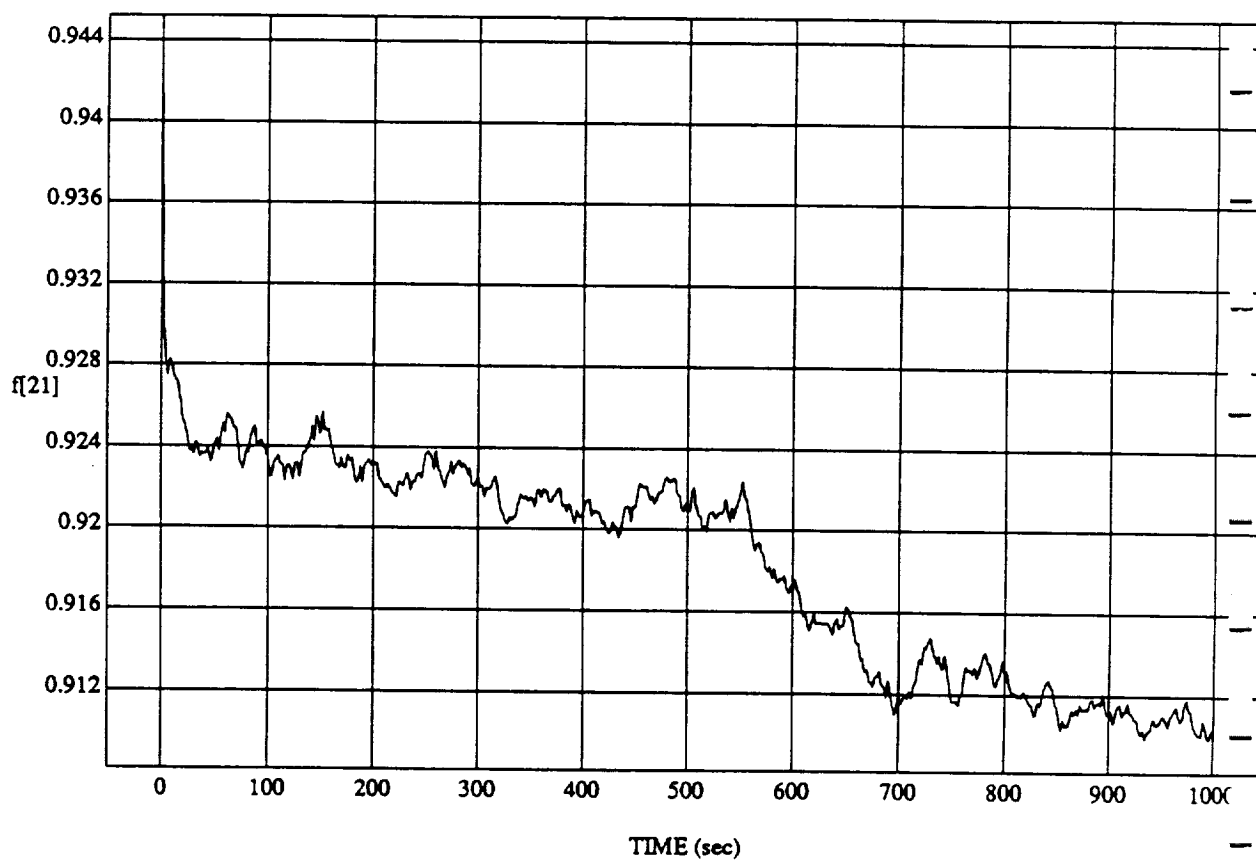


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[21]$  vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



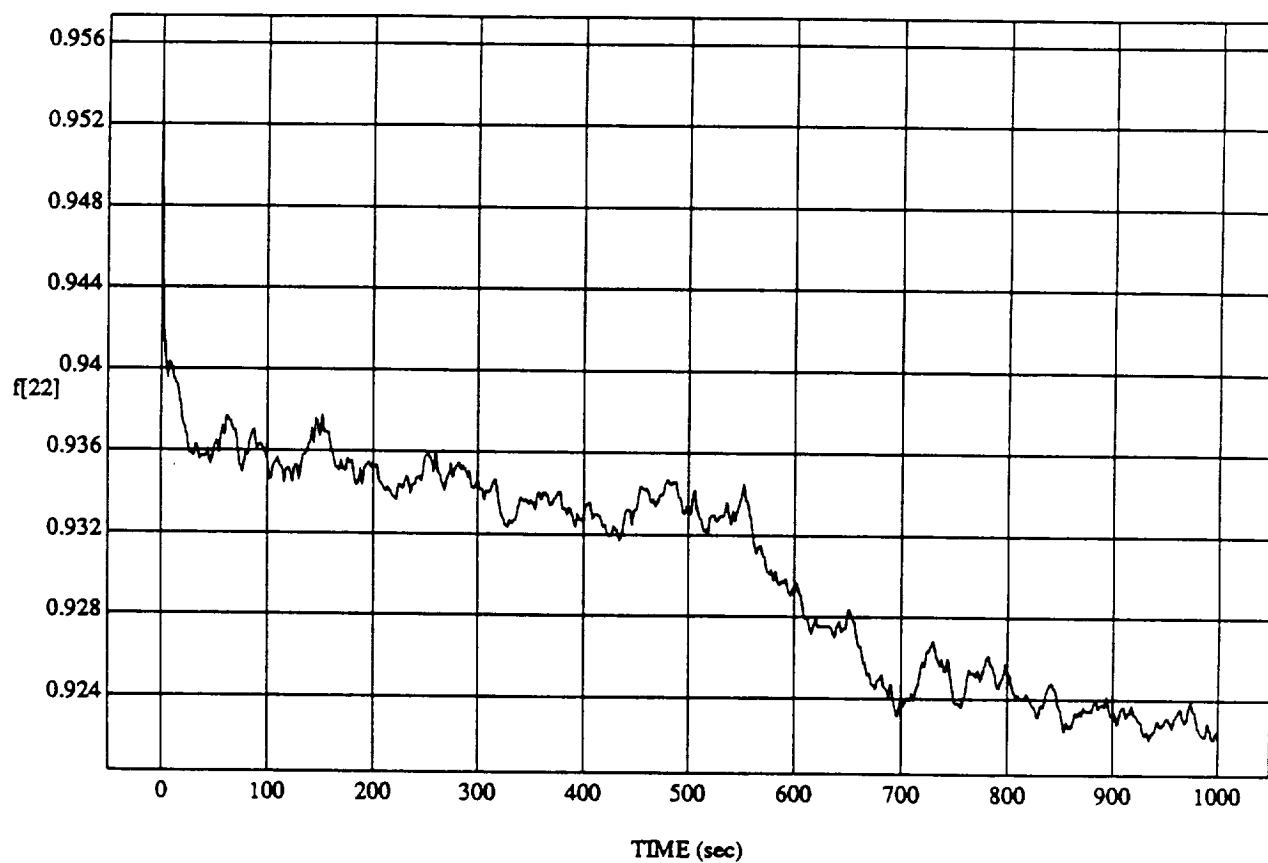
MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[22]$  vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



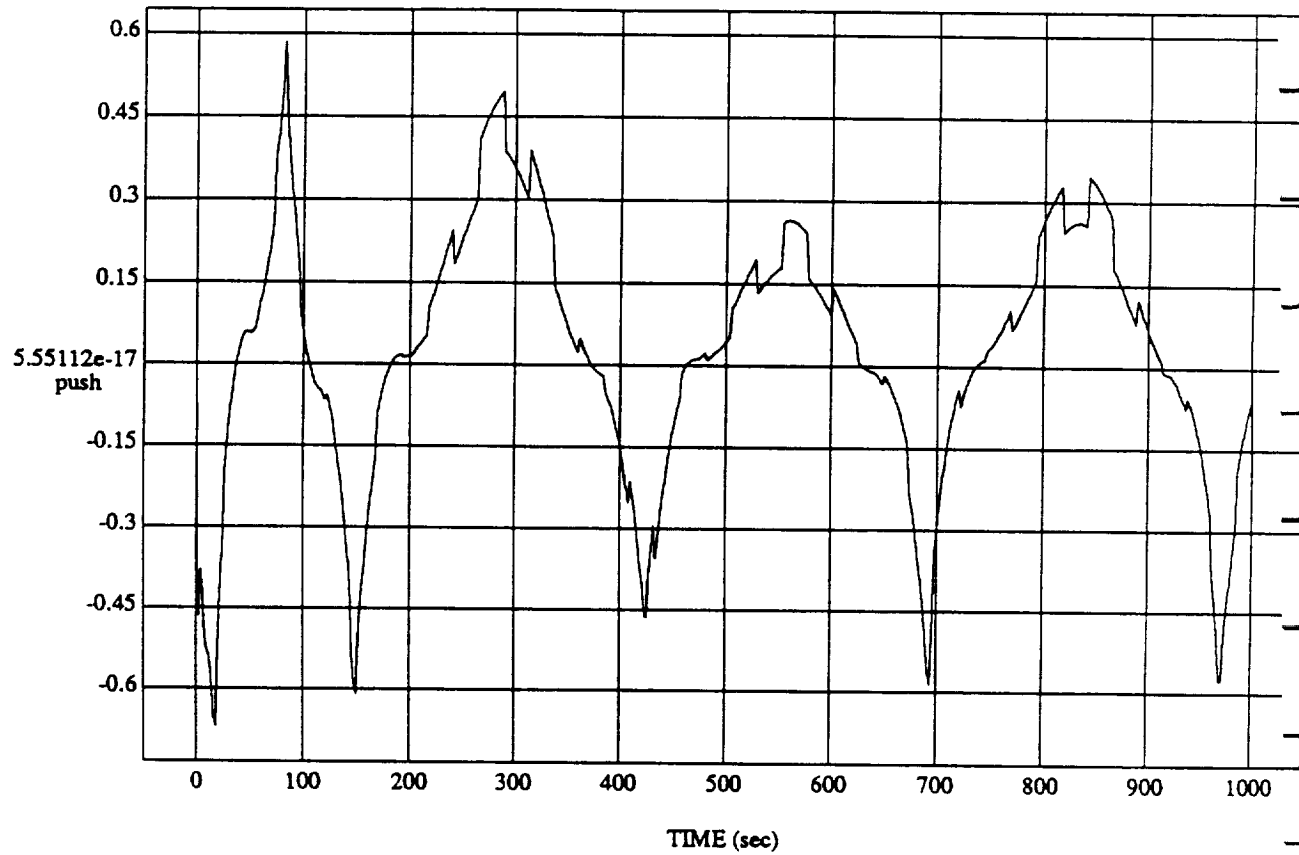
MODULE: ORB\_FUZZ\_BATCH.lear2

DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

push vs TIME

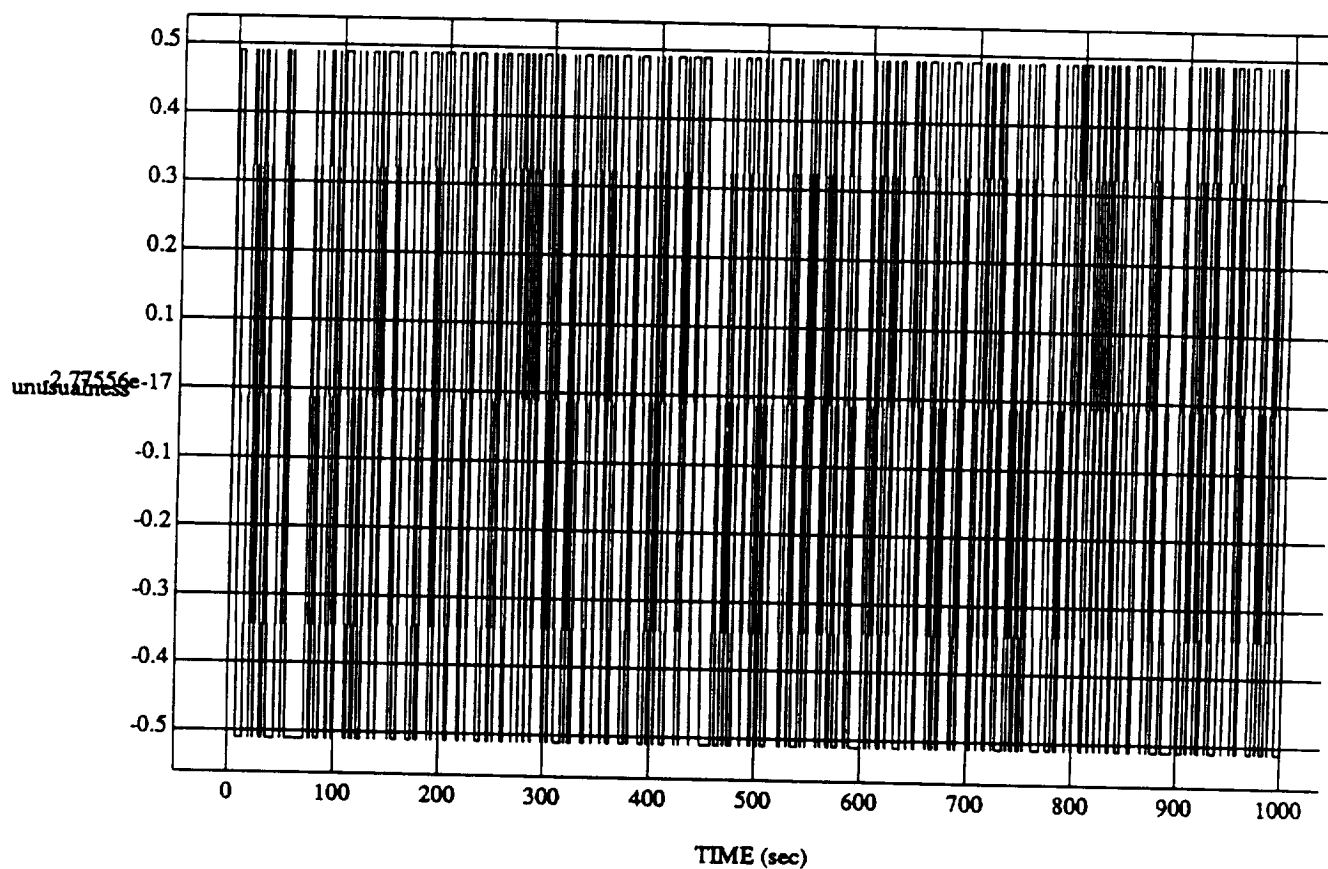
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

unusualness vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

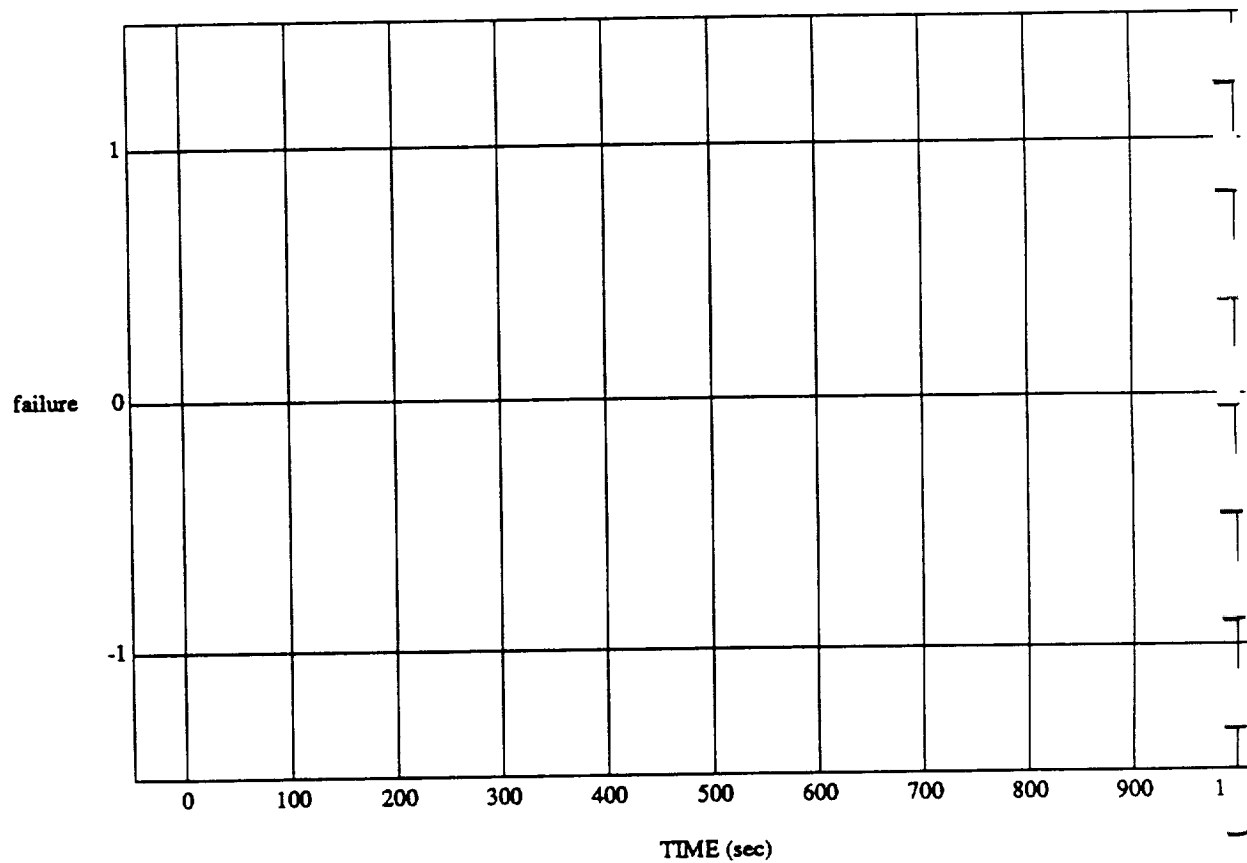


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

failure vs TIME

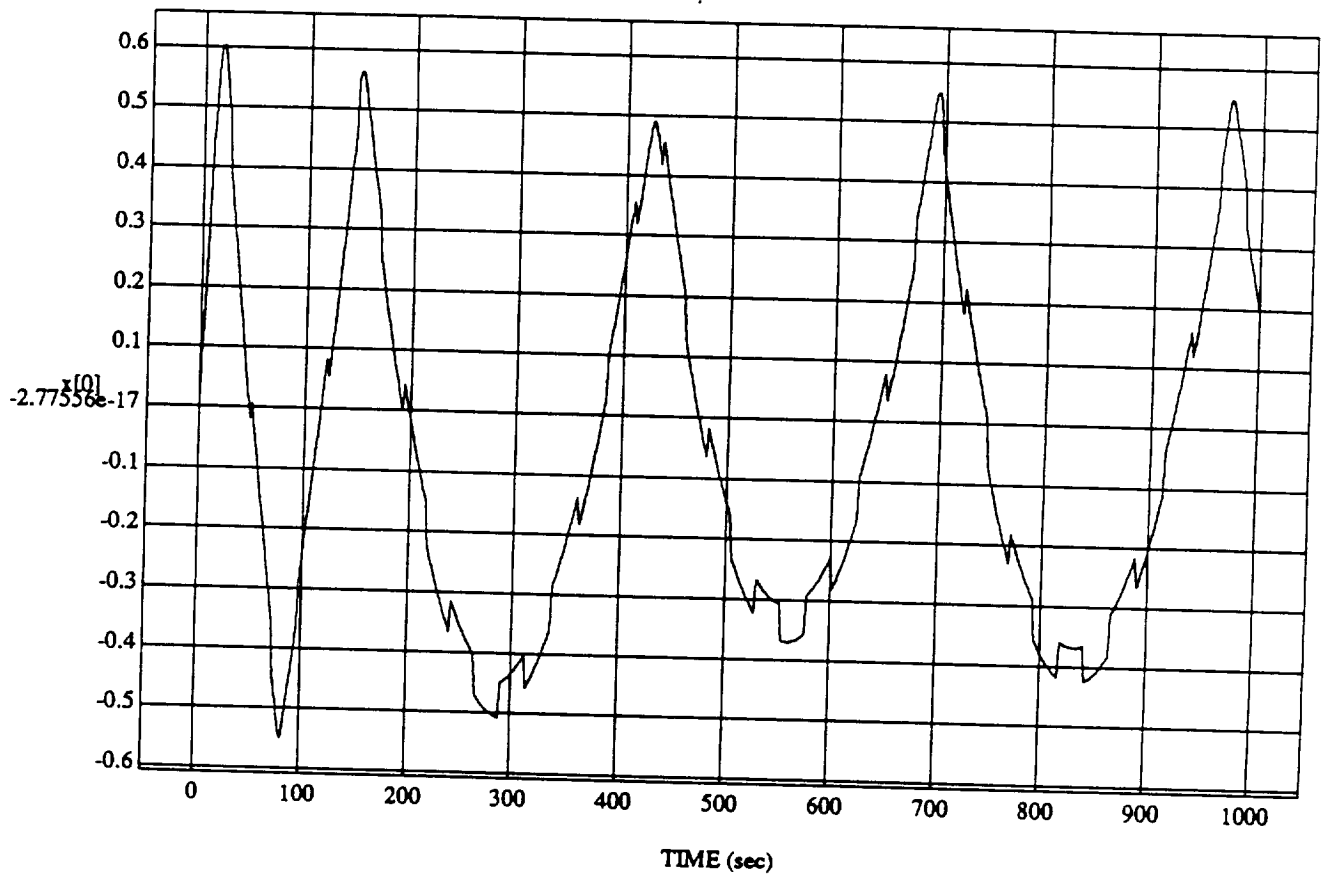
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCHLearn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

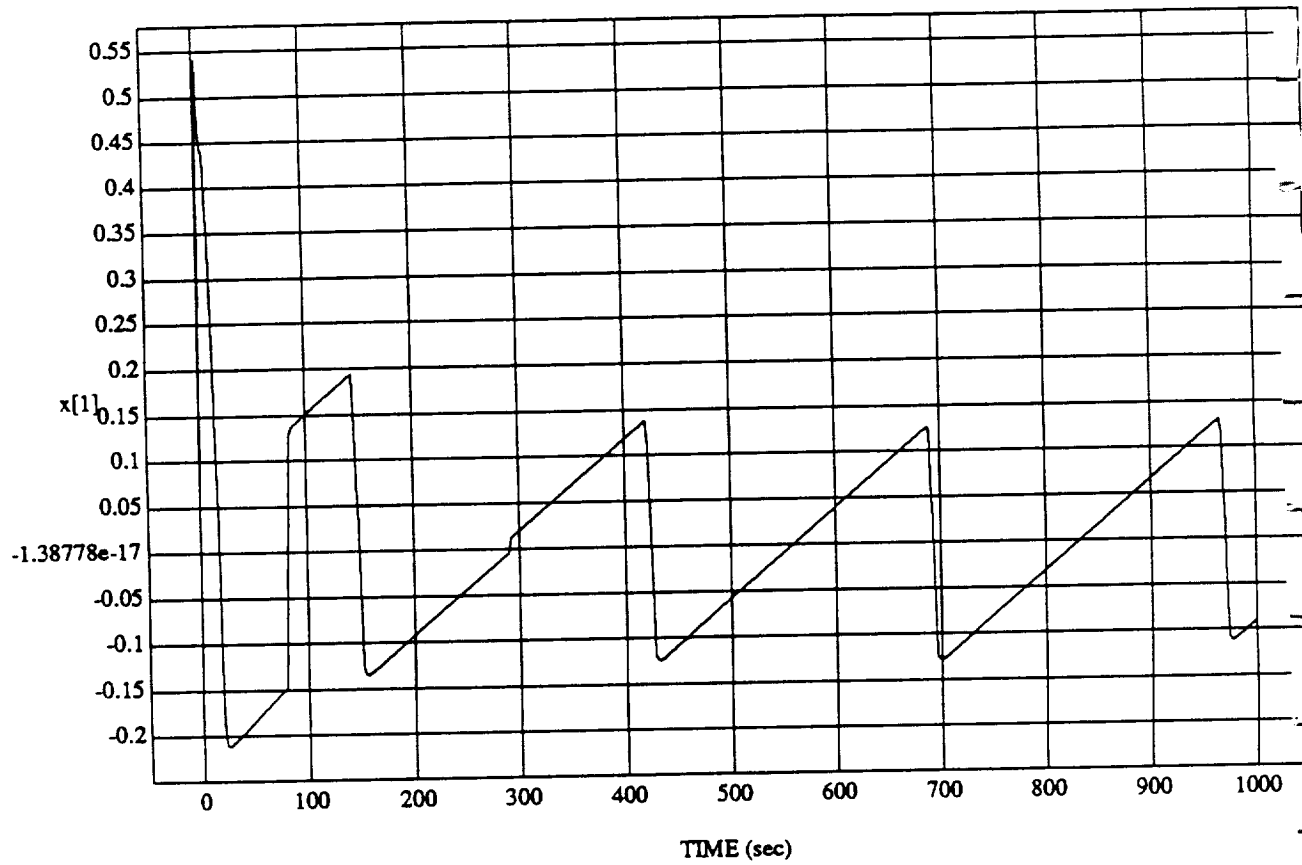
$x[0]$  vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$x[1]$  vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

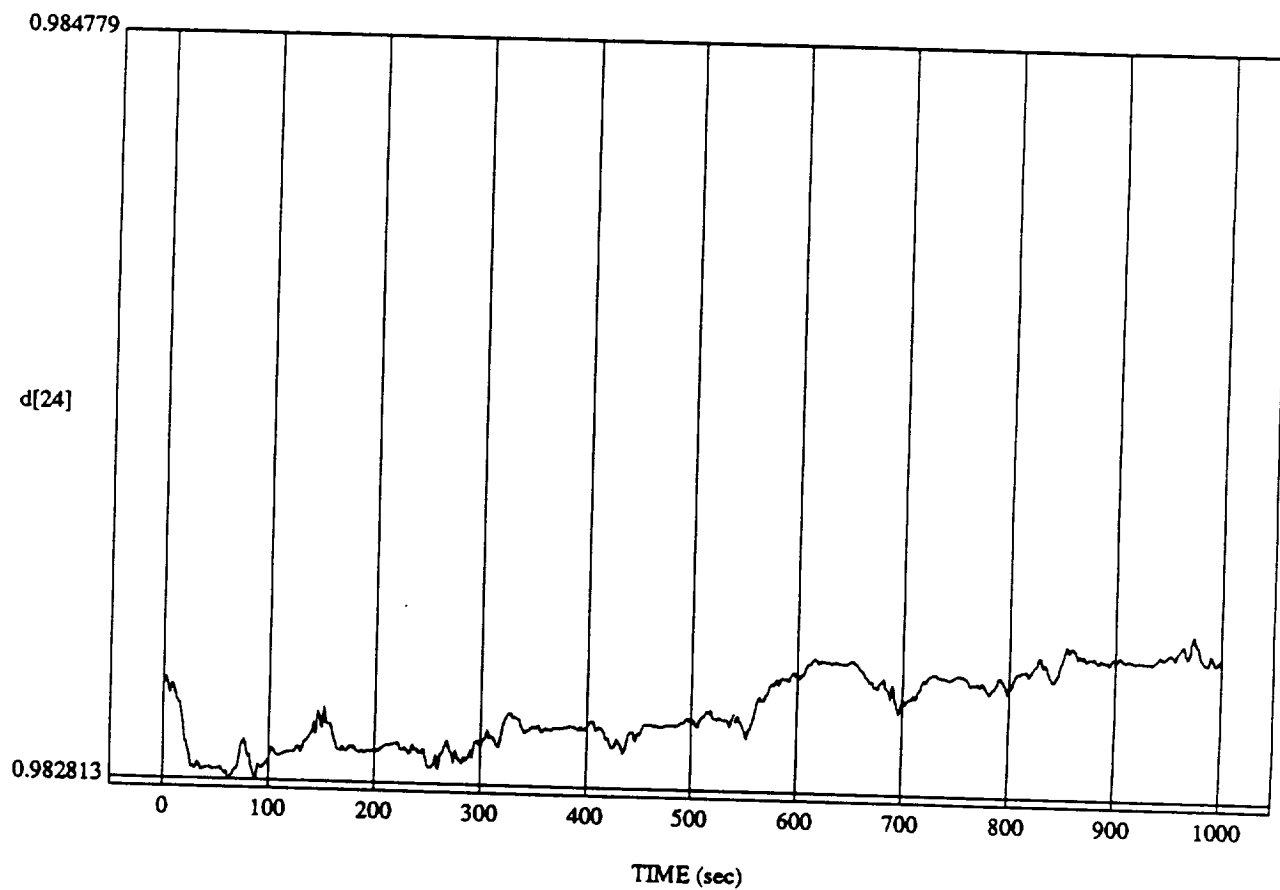


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[24] vs TIME

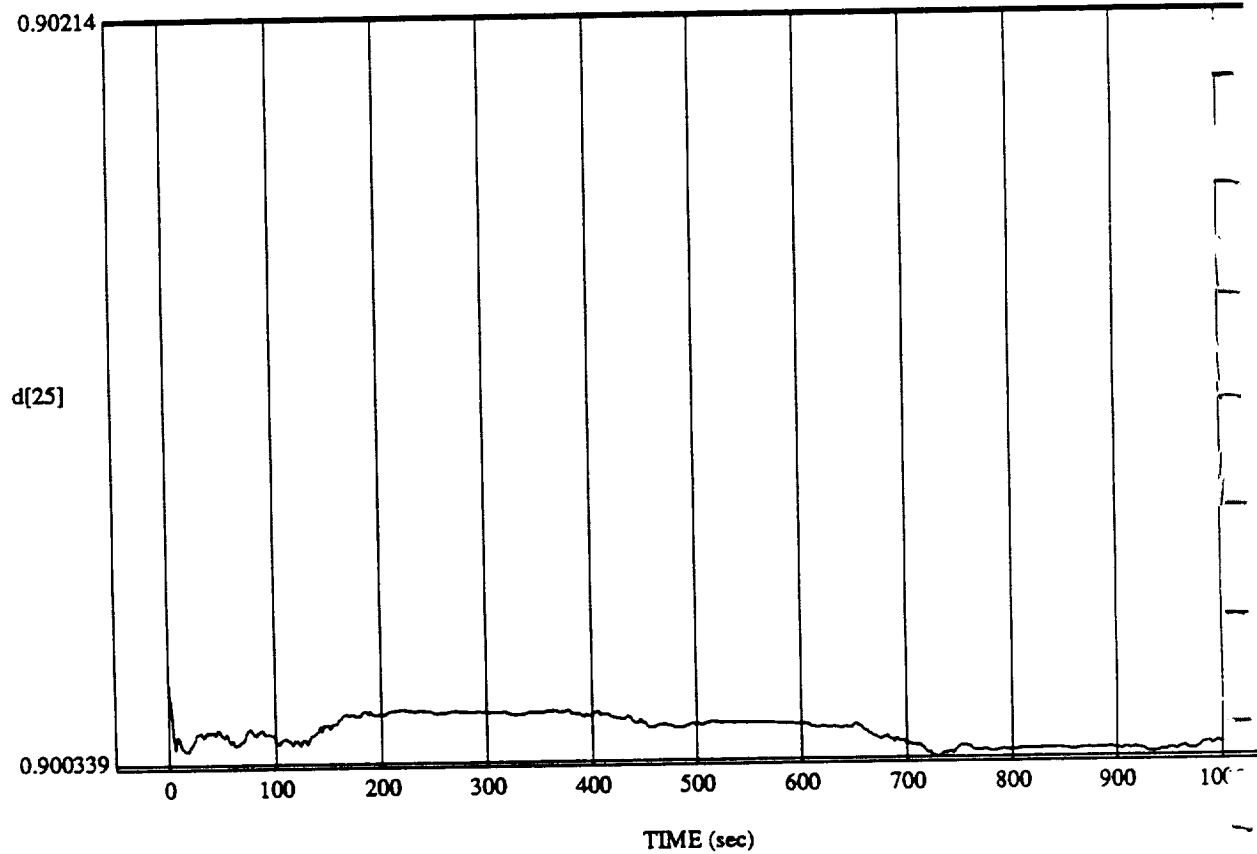
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[25] vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



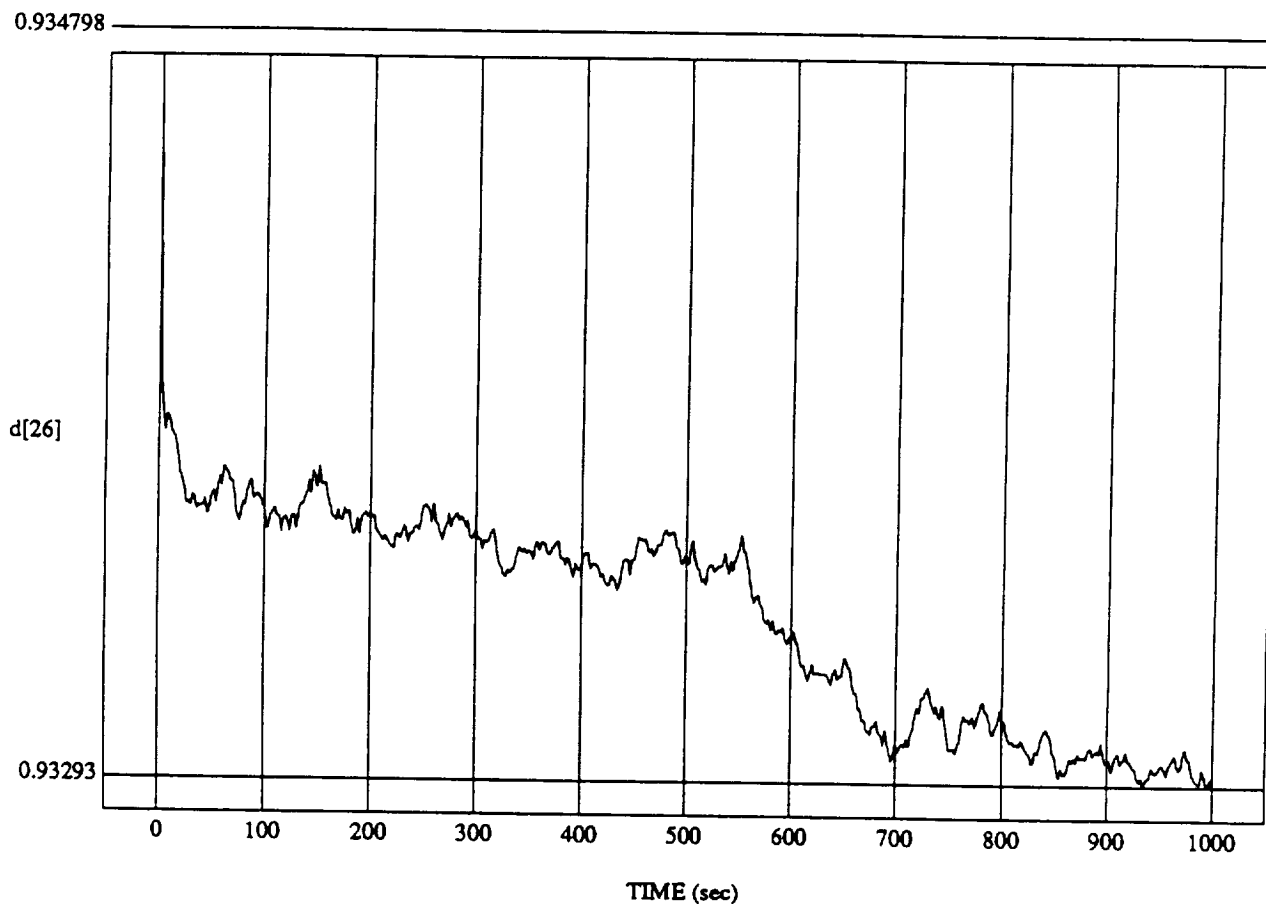
MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[26] vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



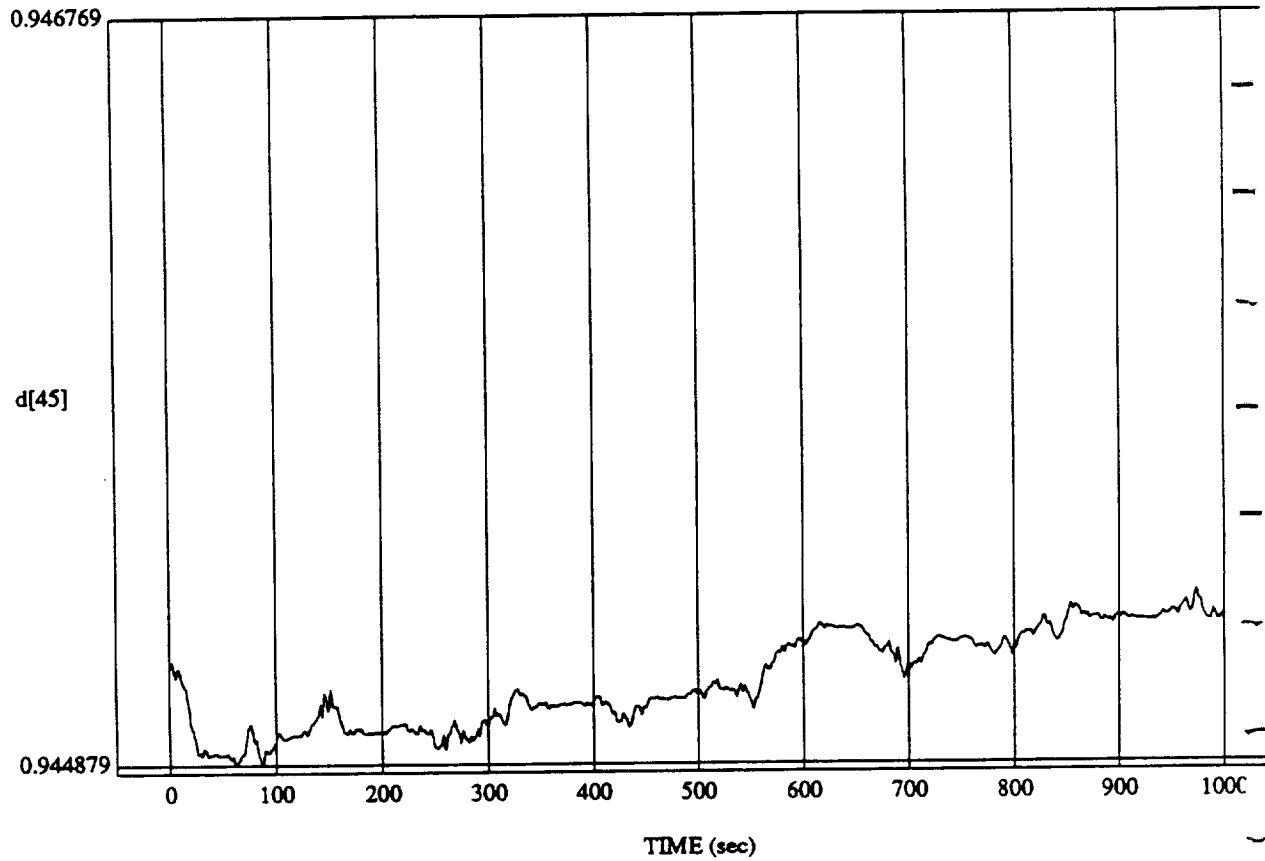
MODULE: ORB\_FUZZ\_BATCH.lear2

DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[45] vs TIME

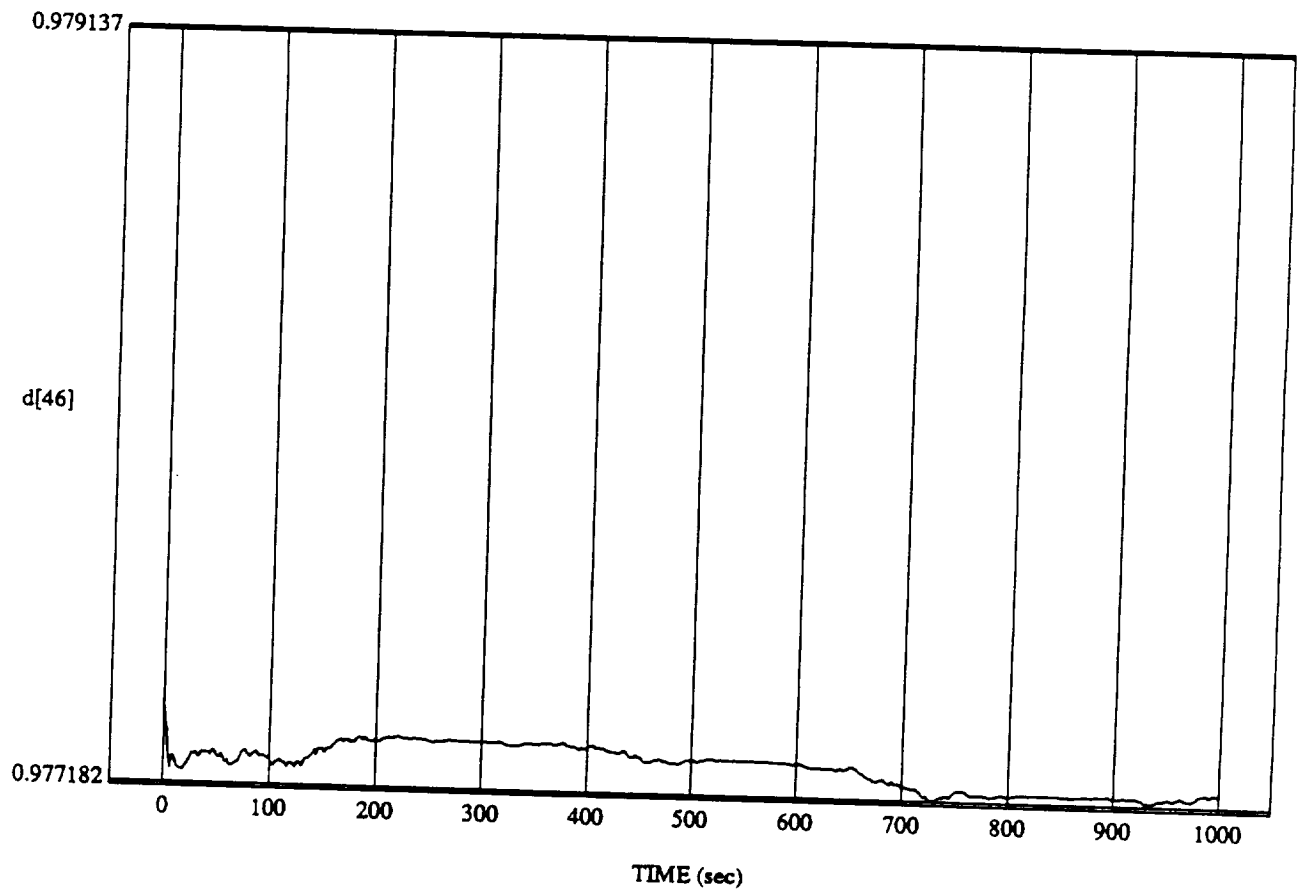
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[46] vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

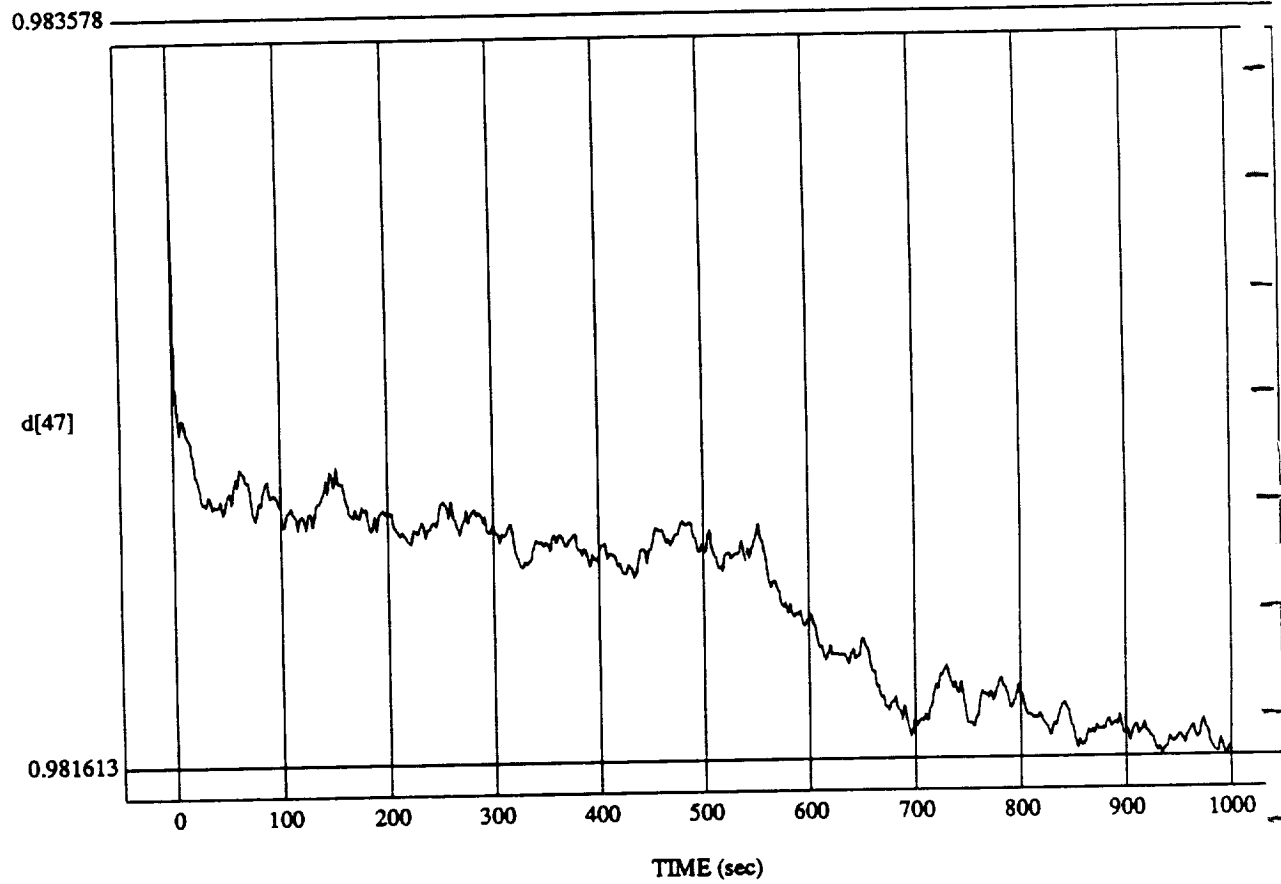


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[47] vs TIME

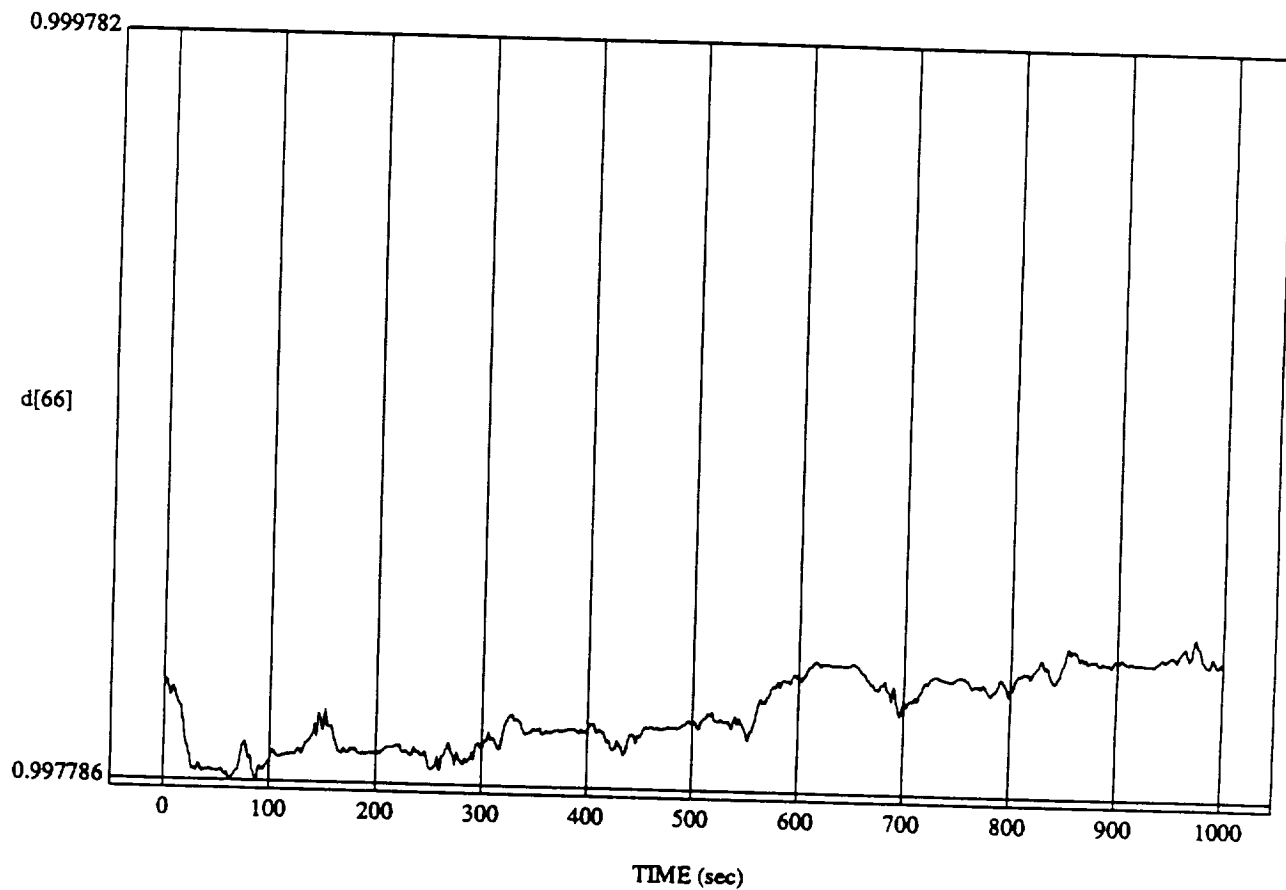
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

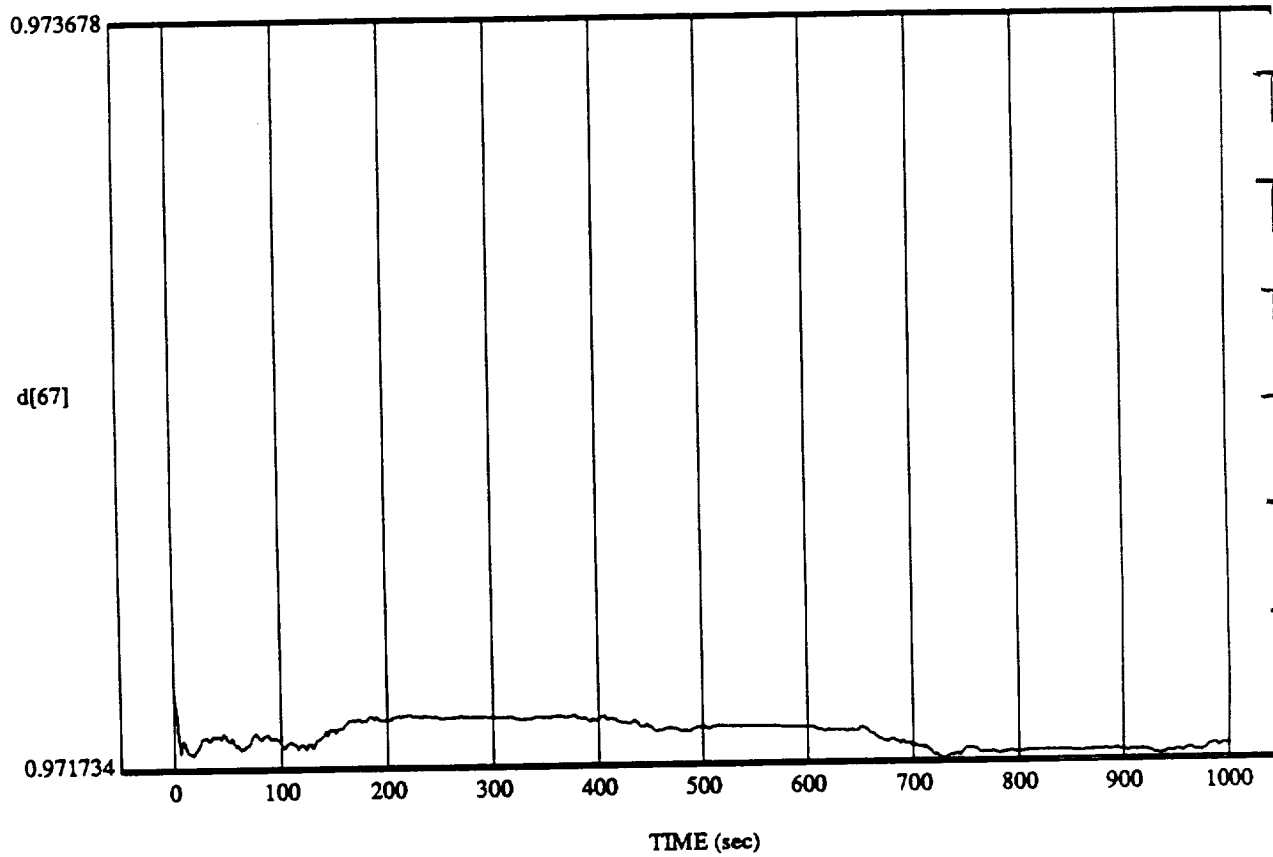
d[66] vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[67] vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

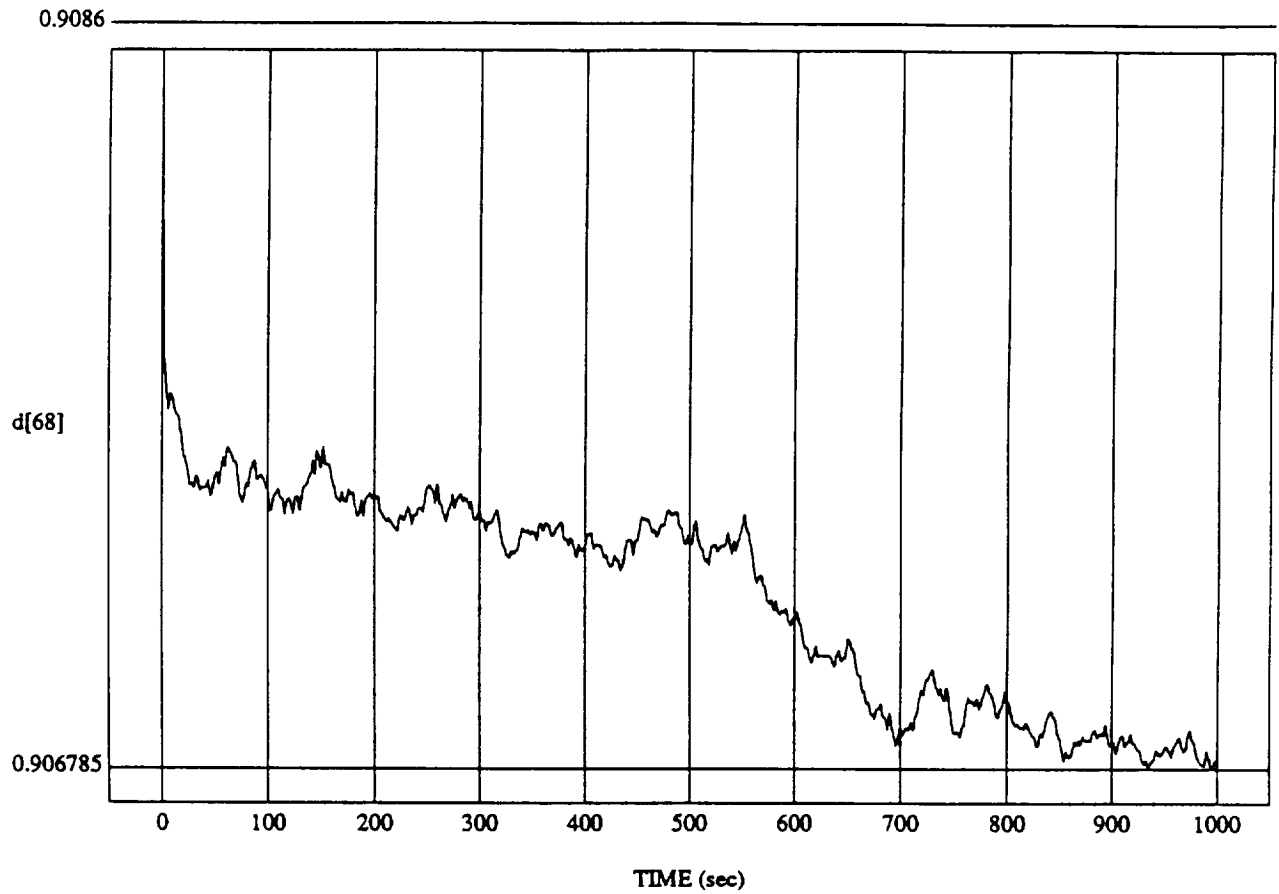


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[68] vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz







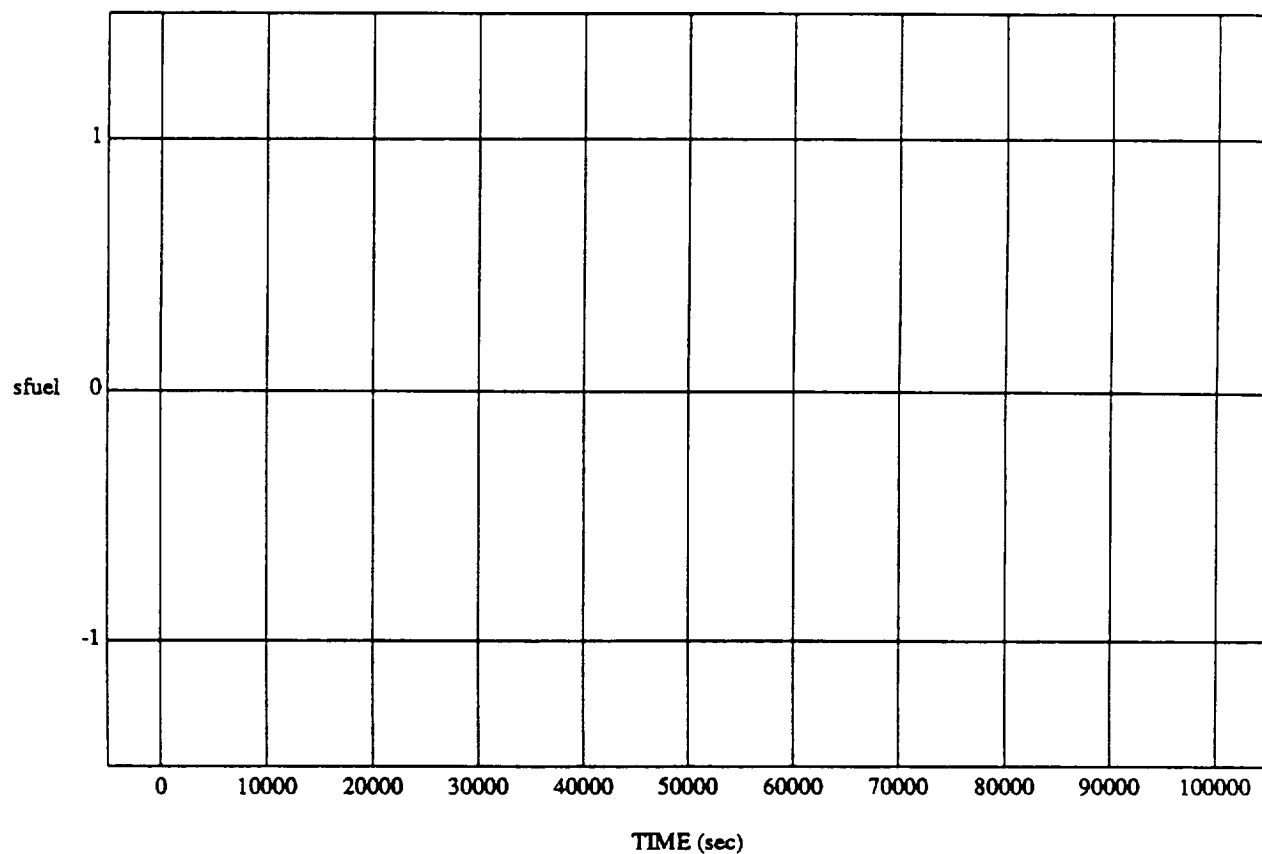


SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

VIII  
(#VII 100000)

sfuel vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

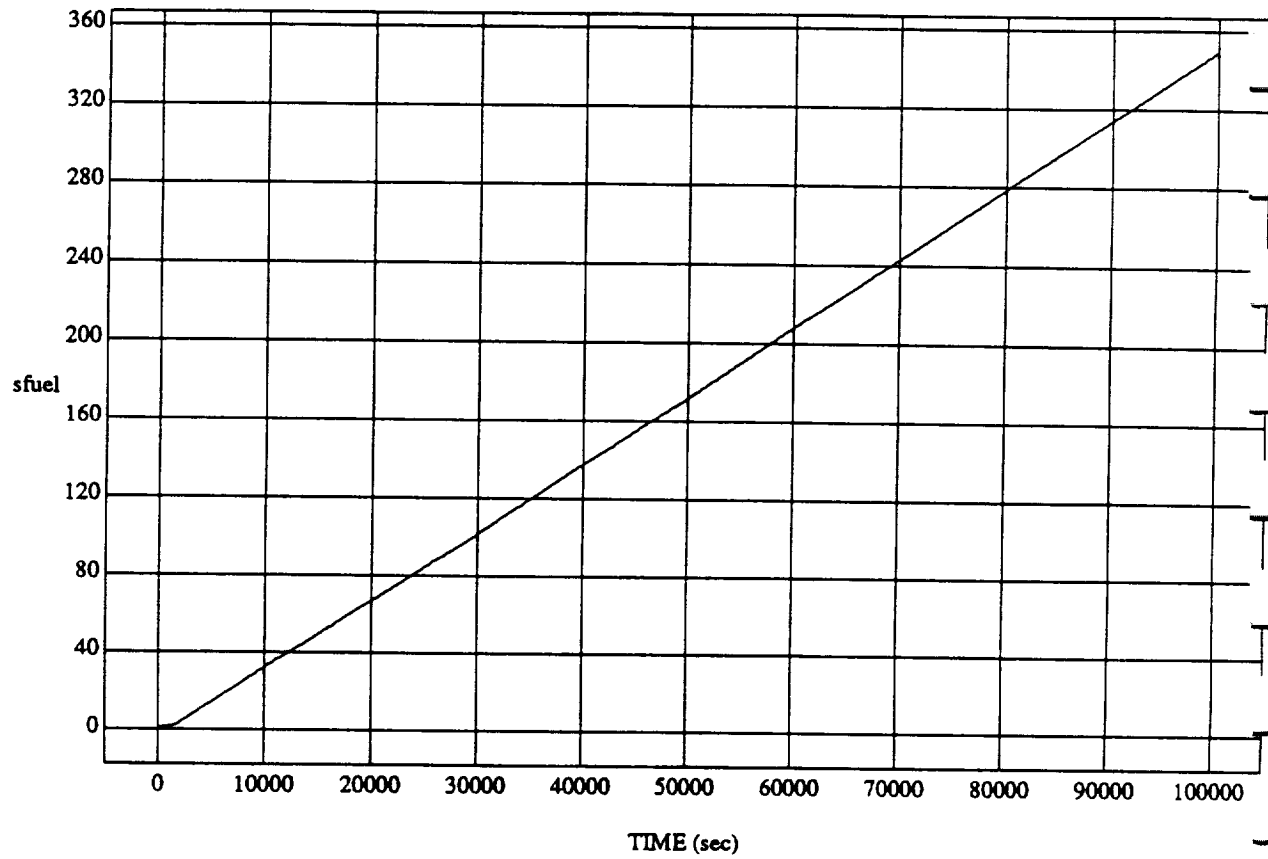


MODULE: ORB\_FUZZ\_BATCH.primary  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME

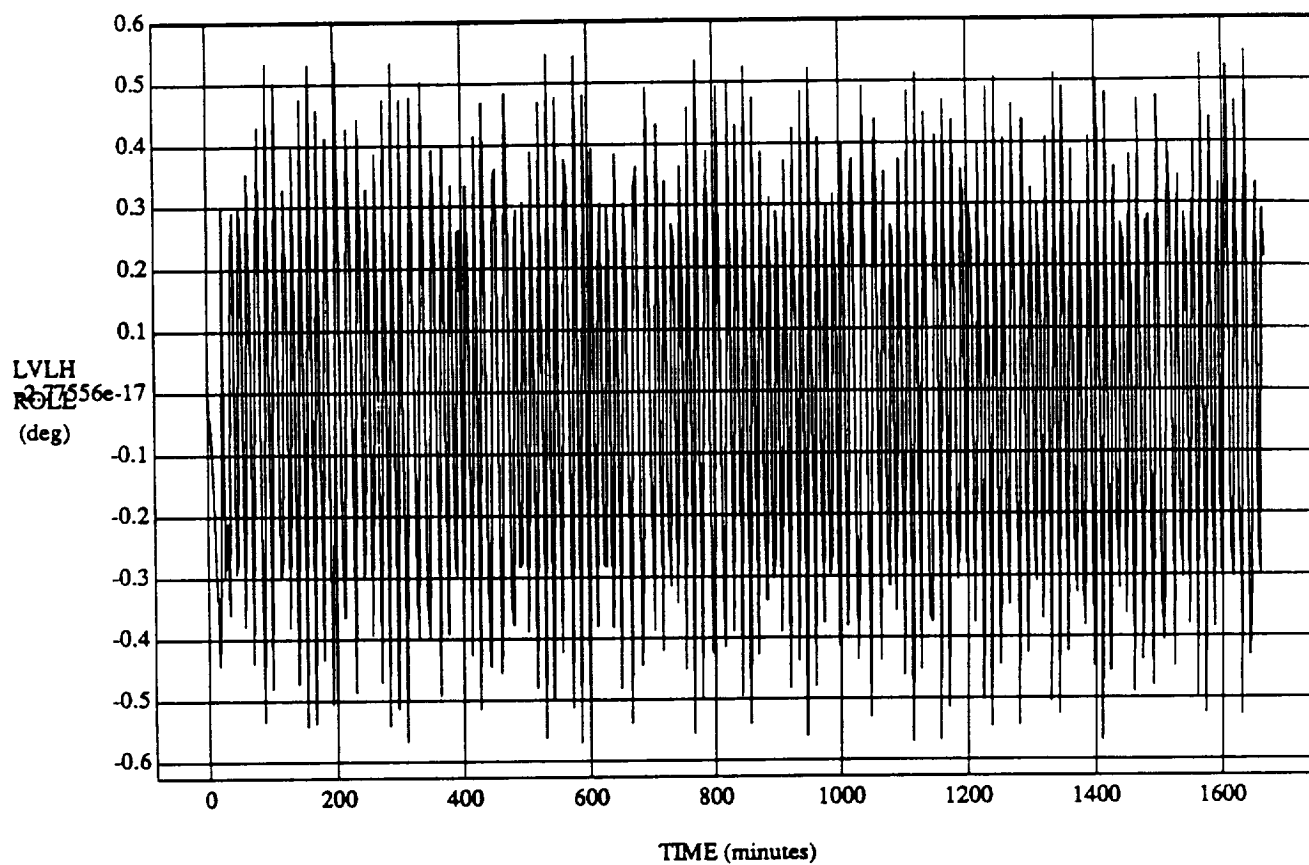
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

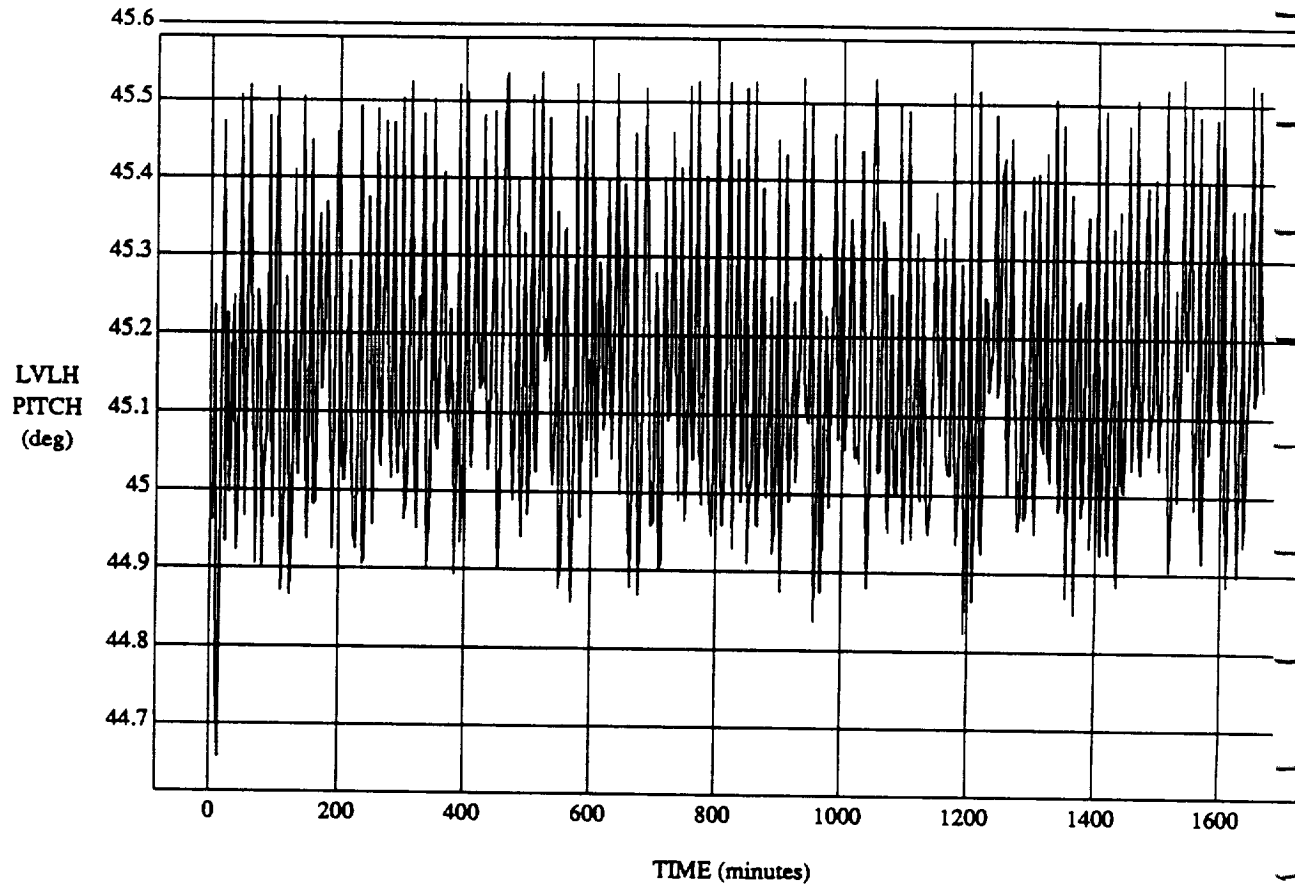
LVLH EULER PYR ROLL vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

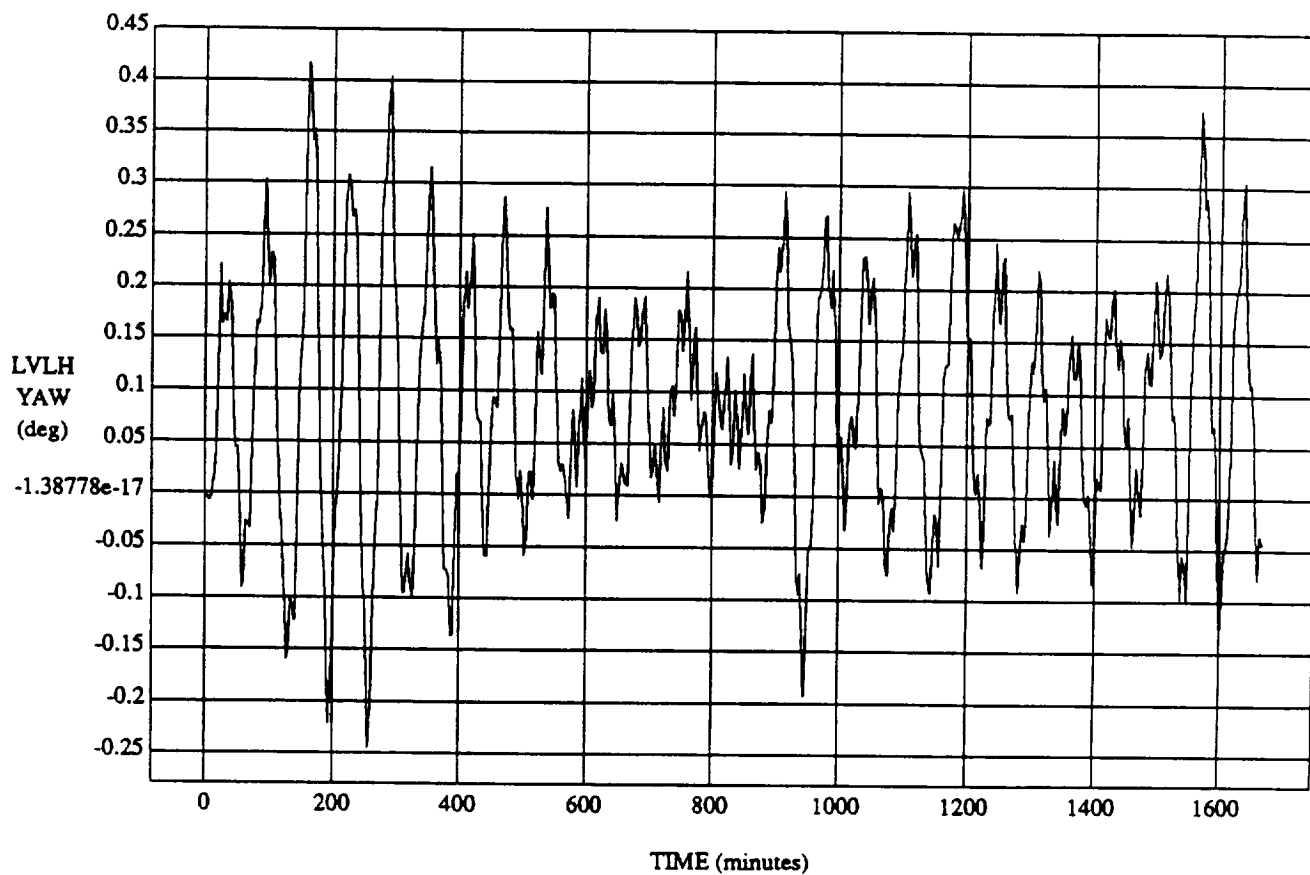
LVLH EULER PYR PITCH vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

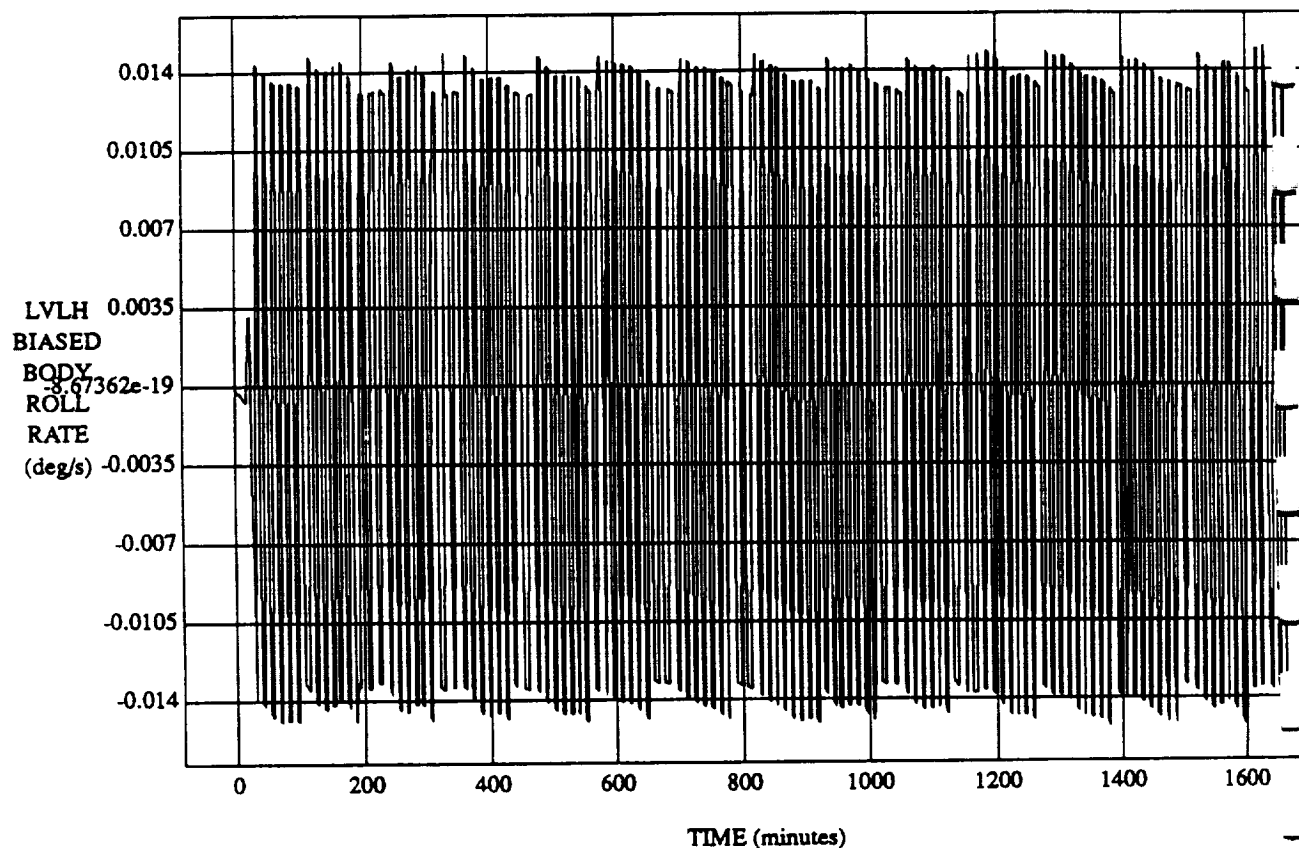
LVLH EULER PYR YAW vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

# LVLH BIASED BODY ROLL RATE vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

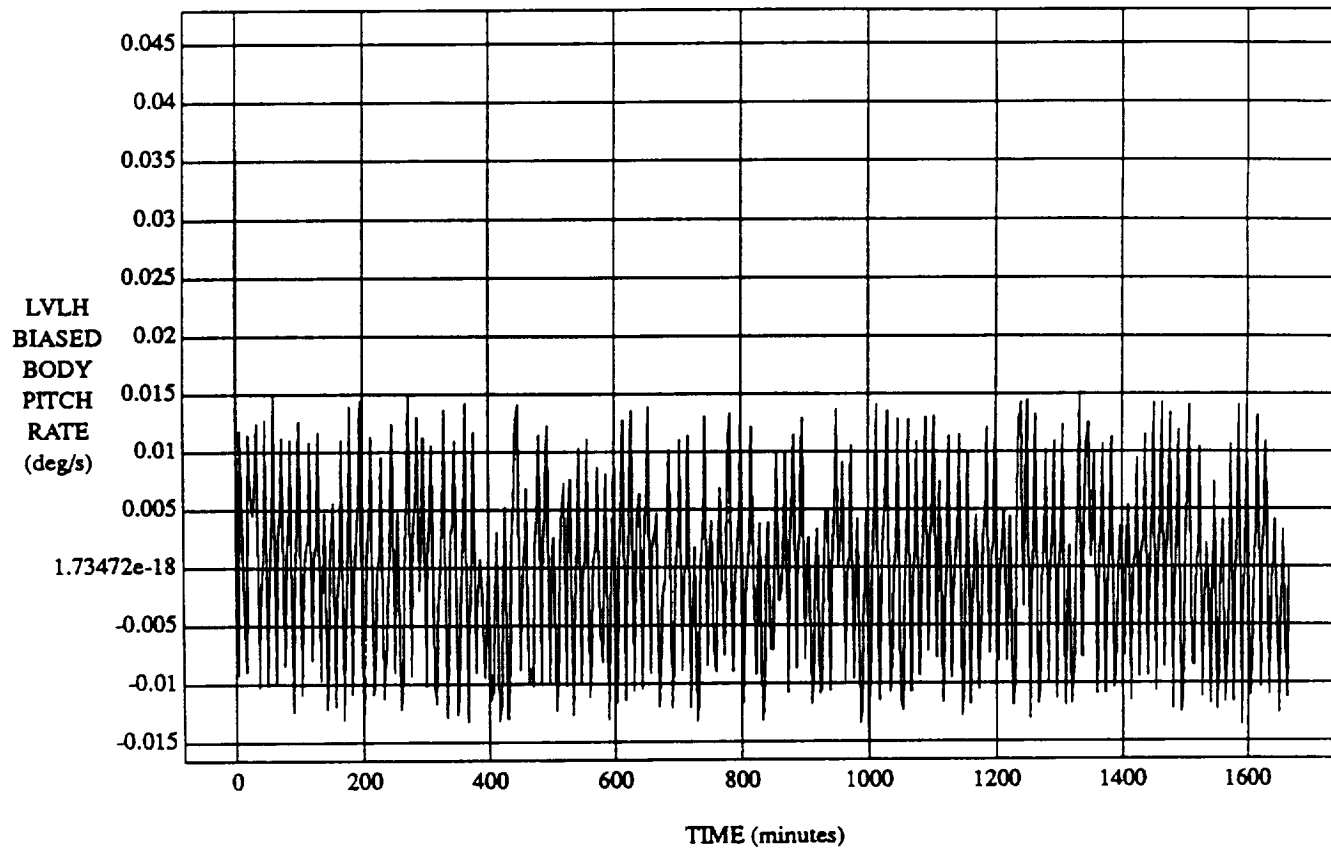


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz



### LVLH BIASED BODY PITCH RATE vs TIME

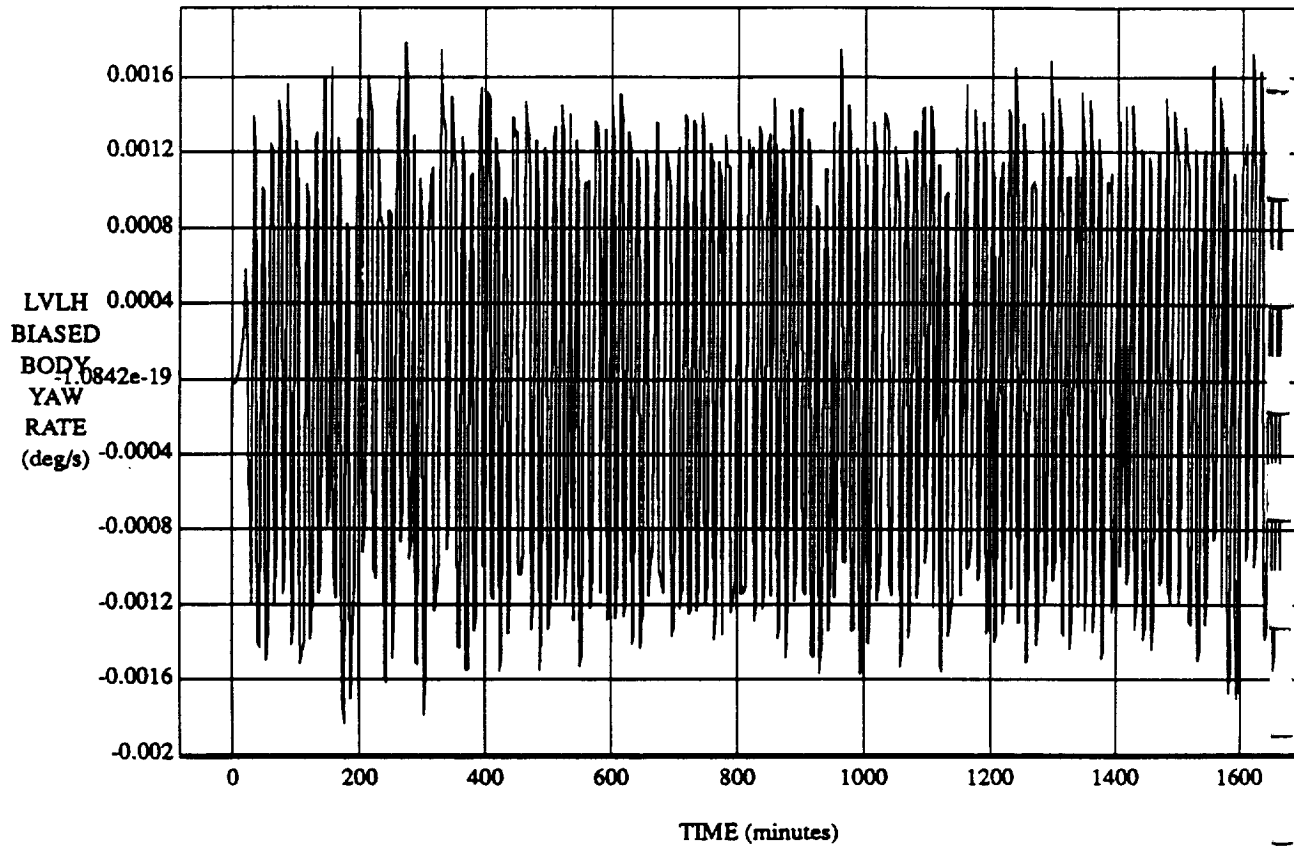
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



VEHICLE: ORB\_FUZZ\_BATCH.state

DATA SAMPLING FREQUENCY: 0.005 Hz

LVLH BIASED BODY YAW RATE vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

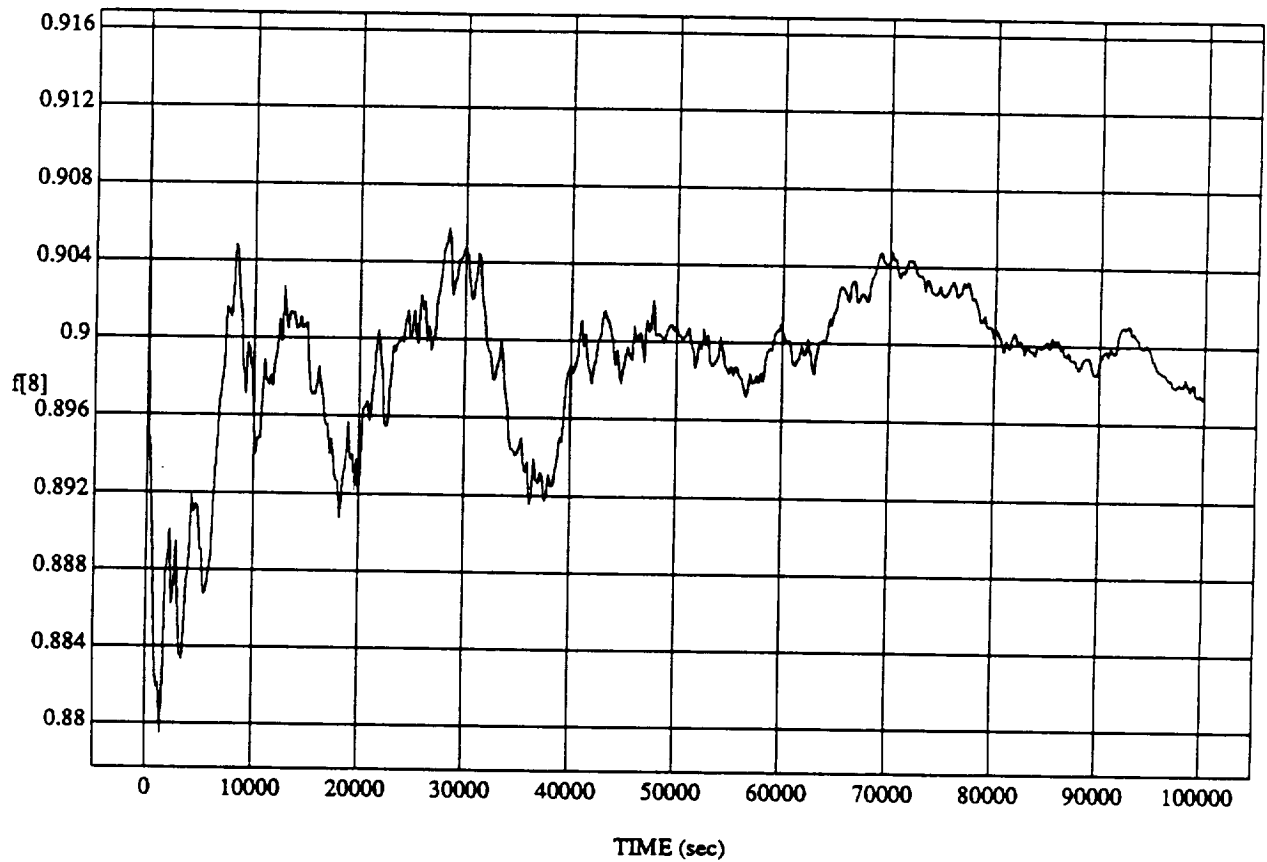


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[8]$  vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

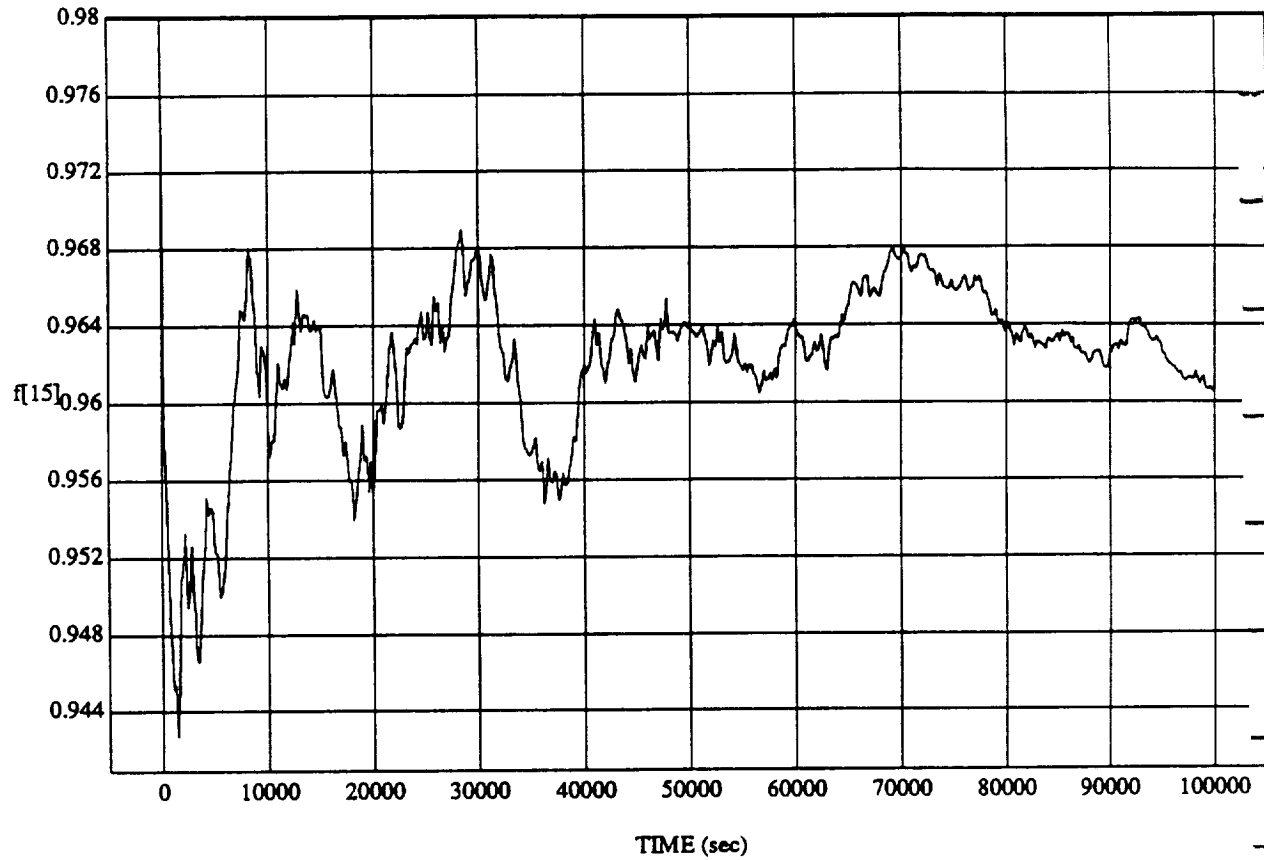


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[15] vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

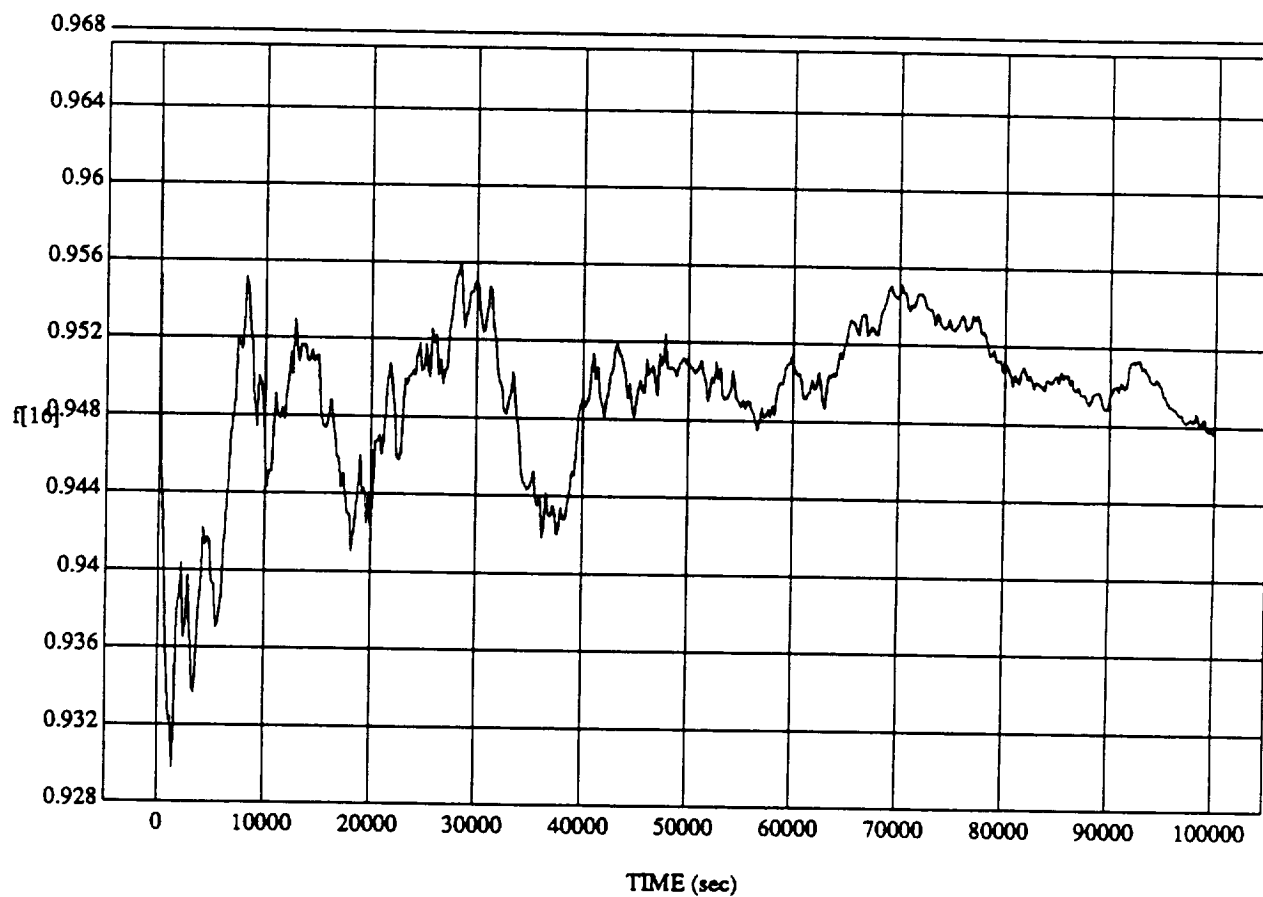


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[16]$  vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



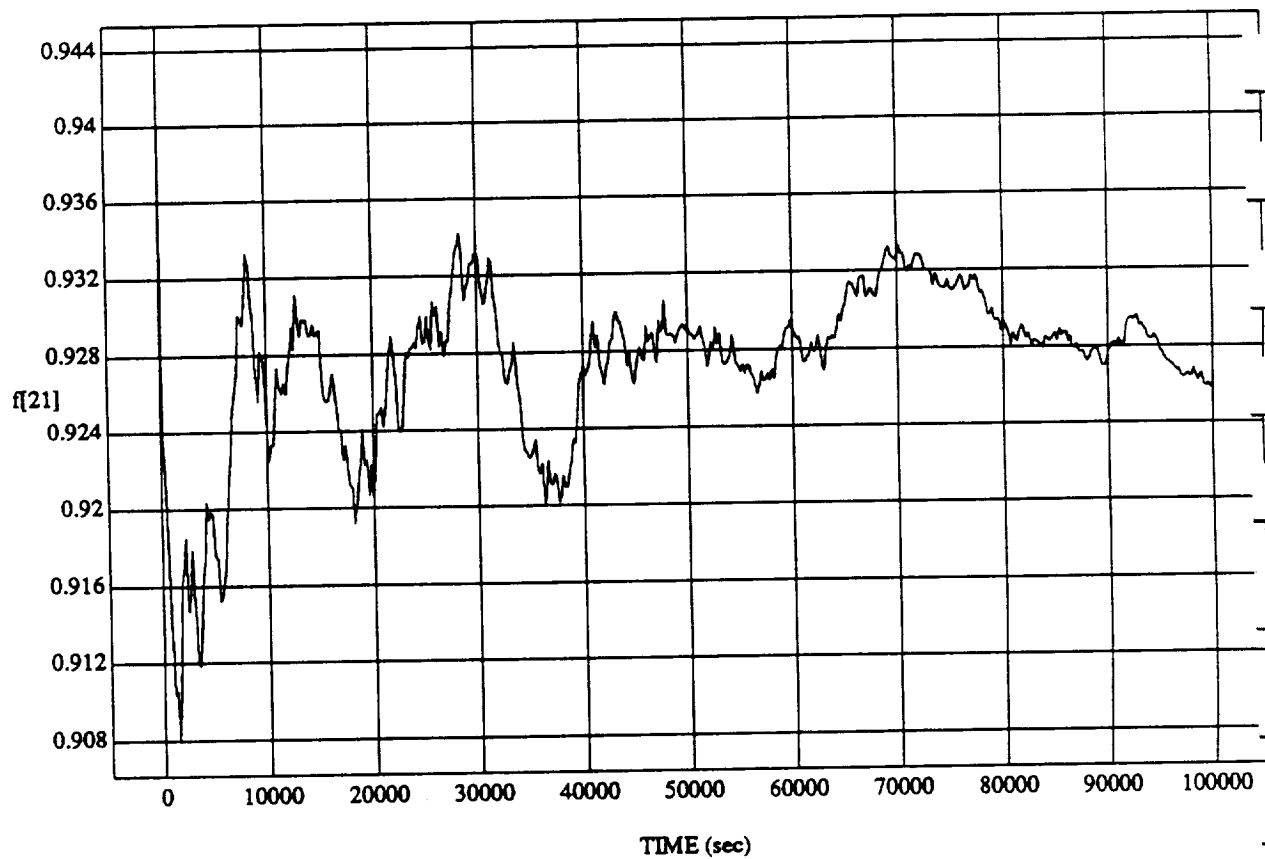
MODULE: ORB\_FUZZ\_BATCH.learm2

DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[21] vs TIME

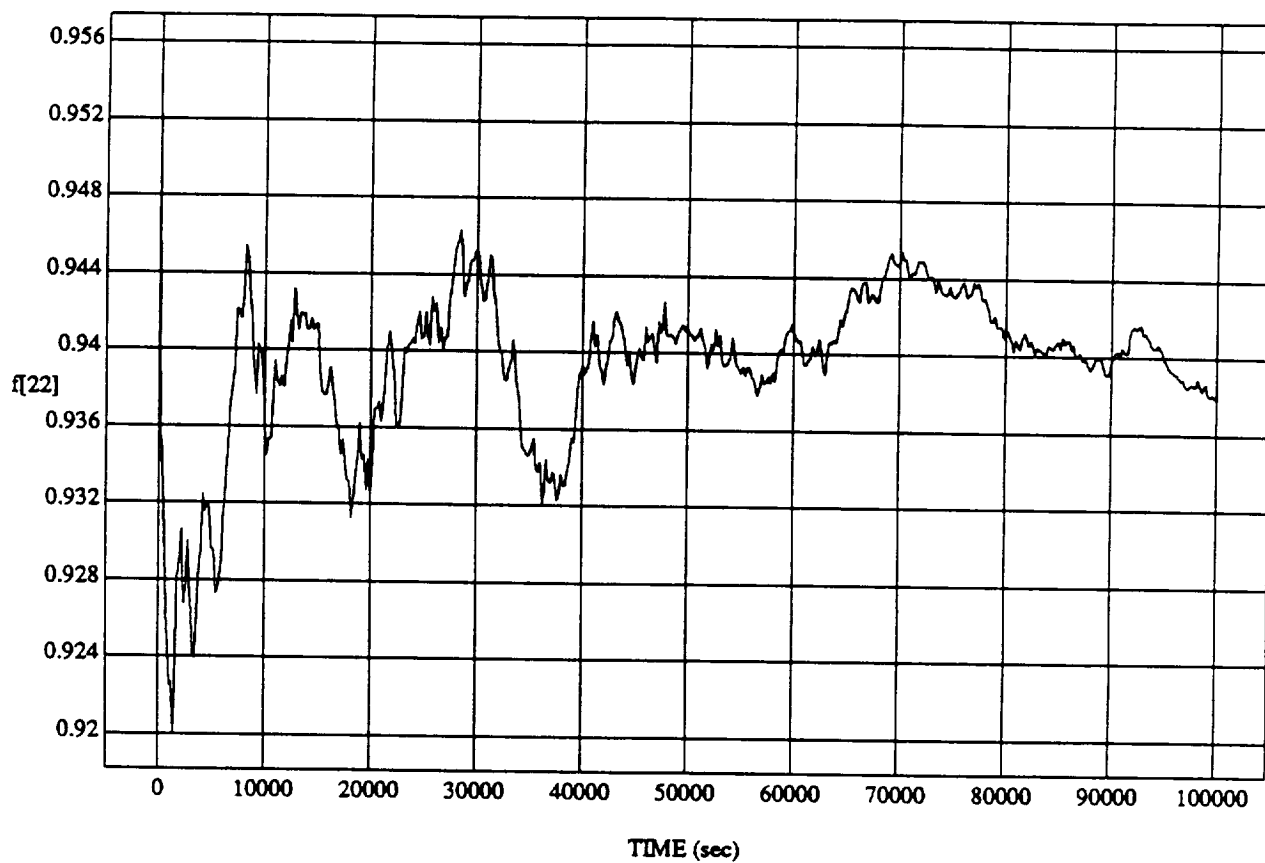
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[22]$  vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

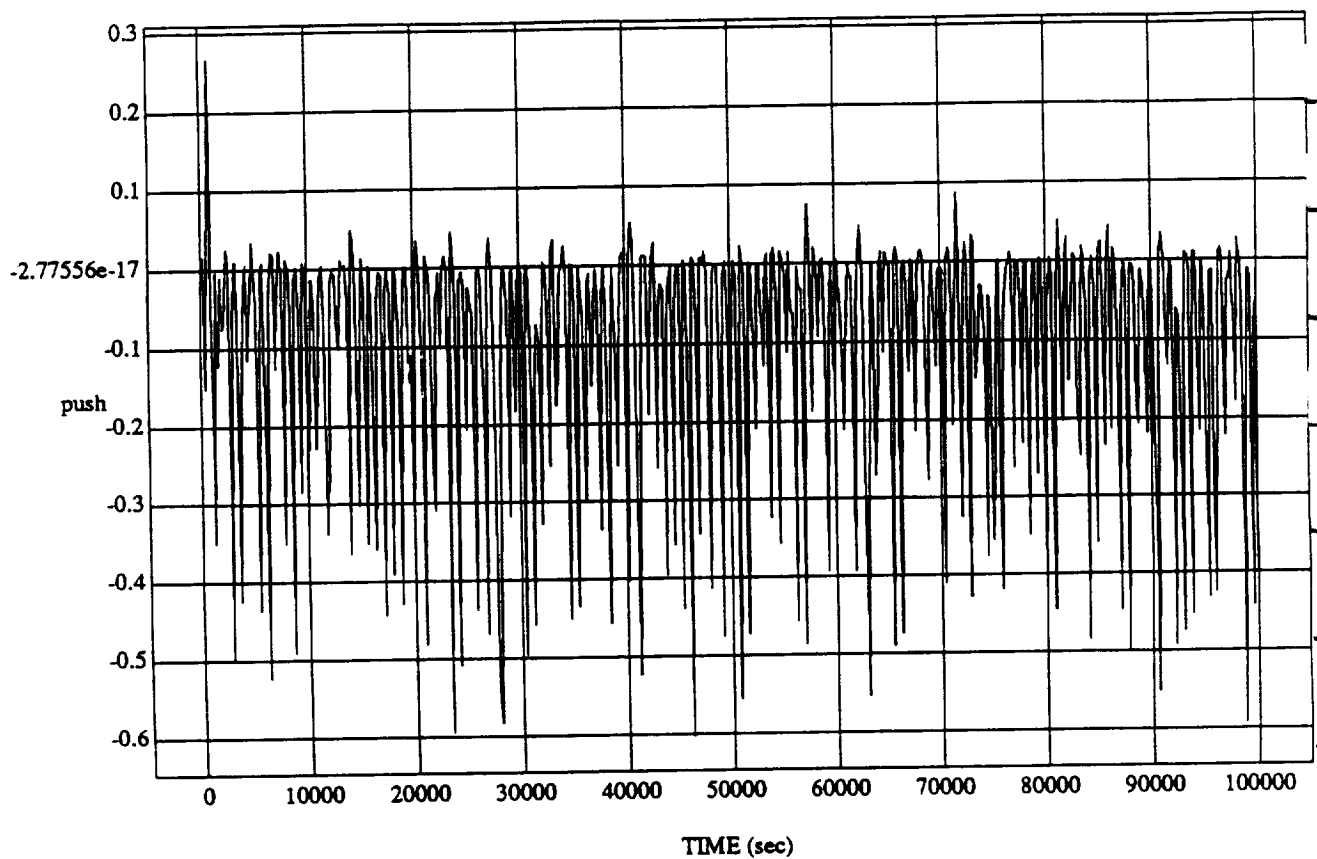


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

push vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



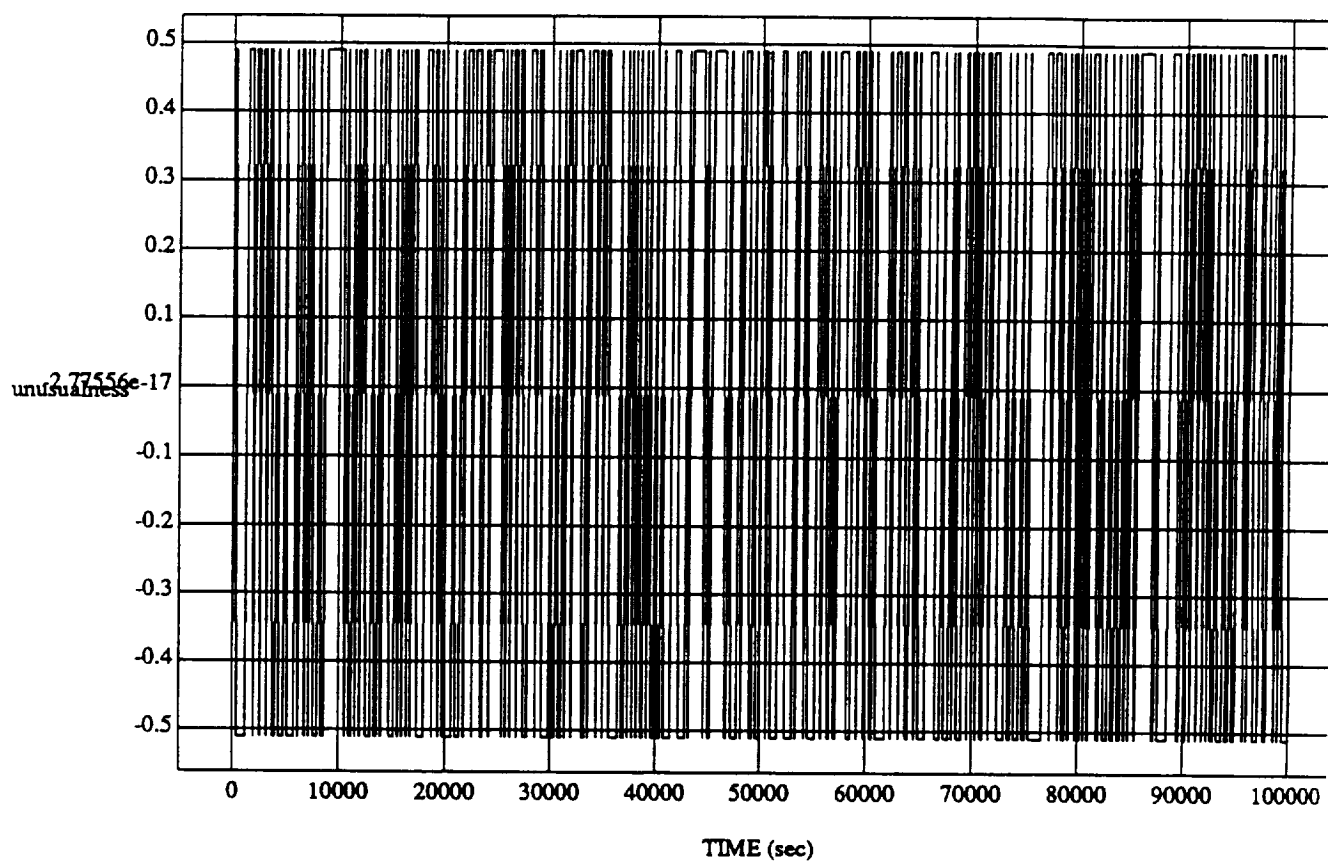
MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

unusualness vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

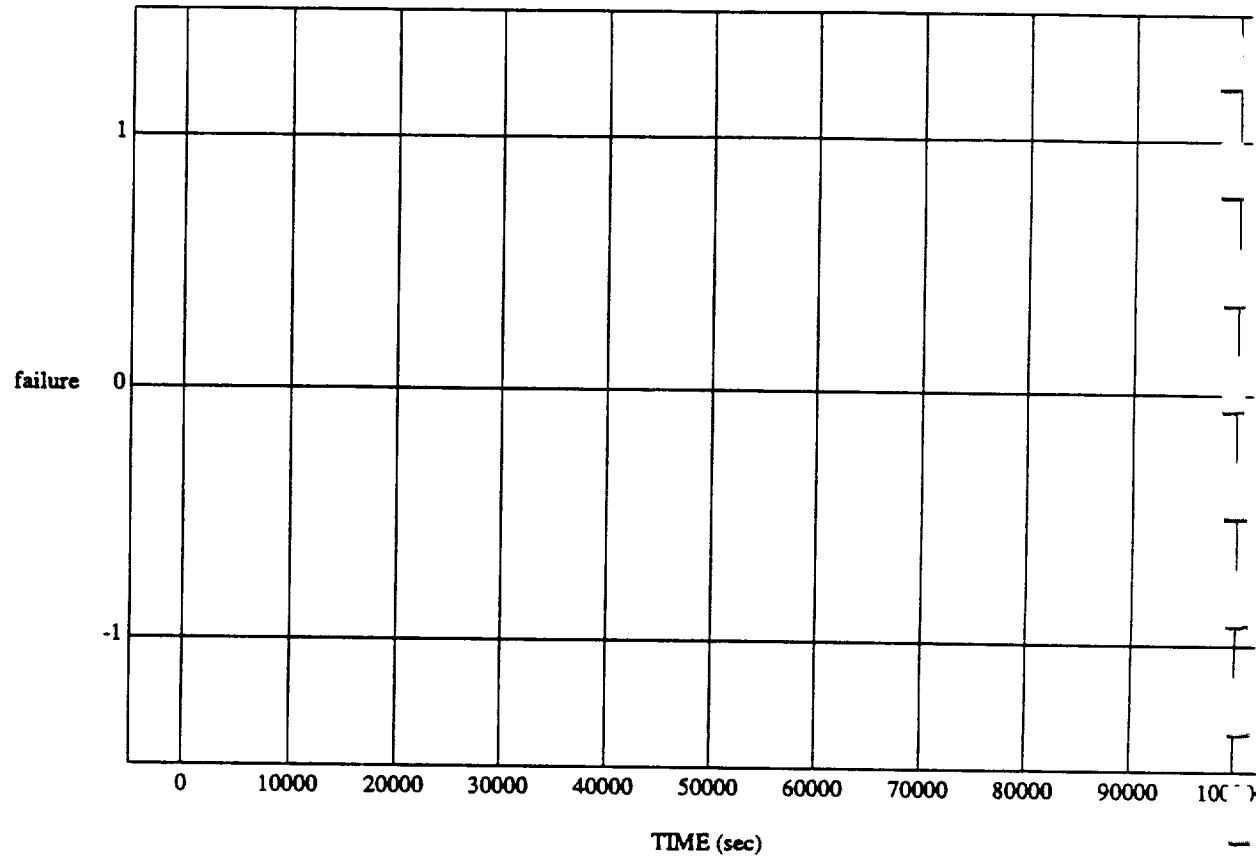


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

failure vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

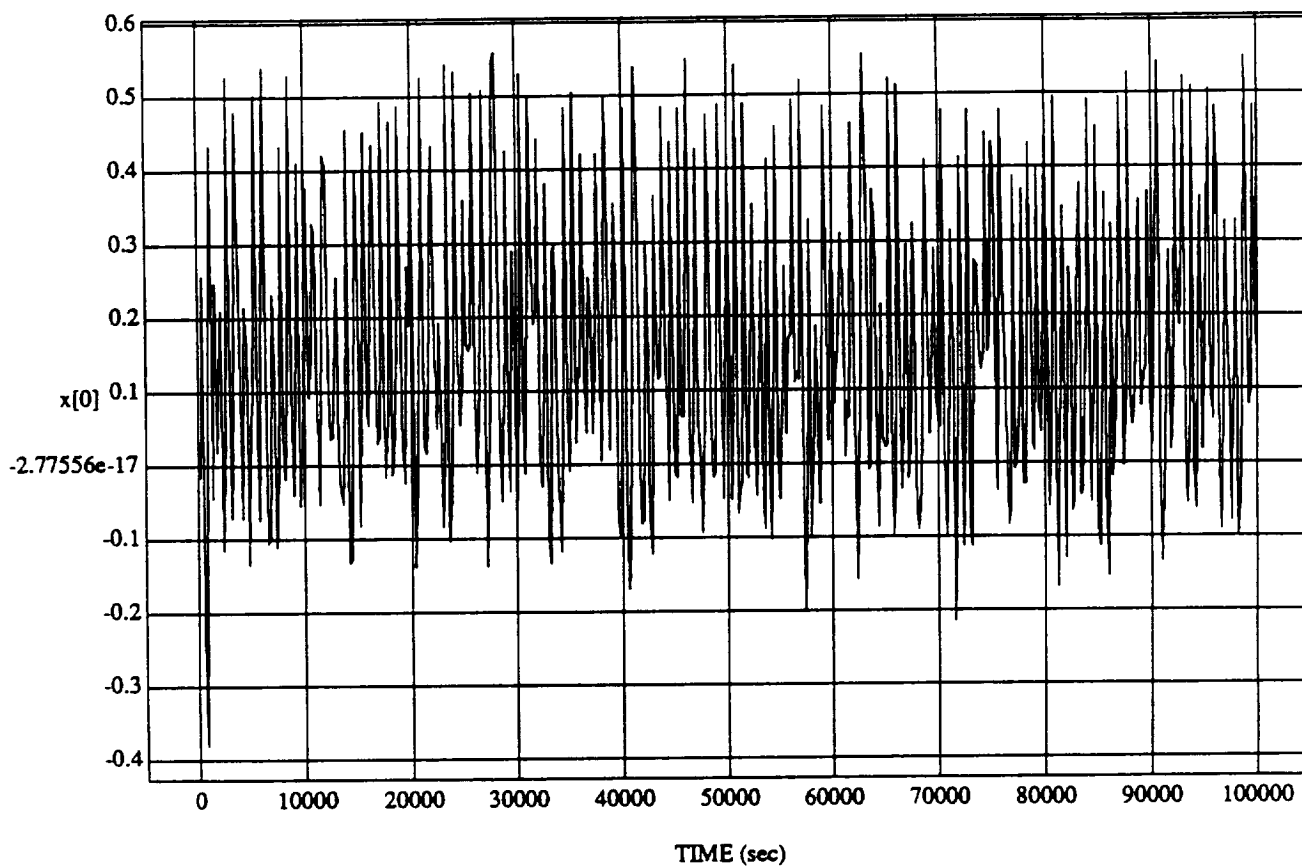


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$x[0]$  vs TIME

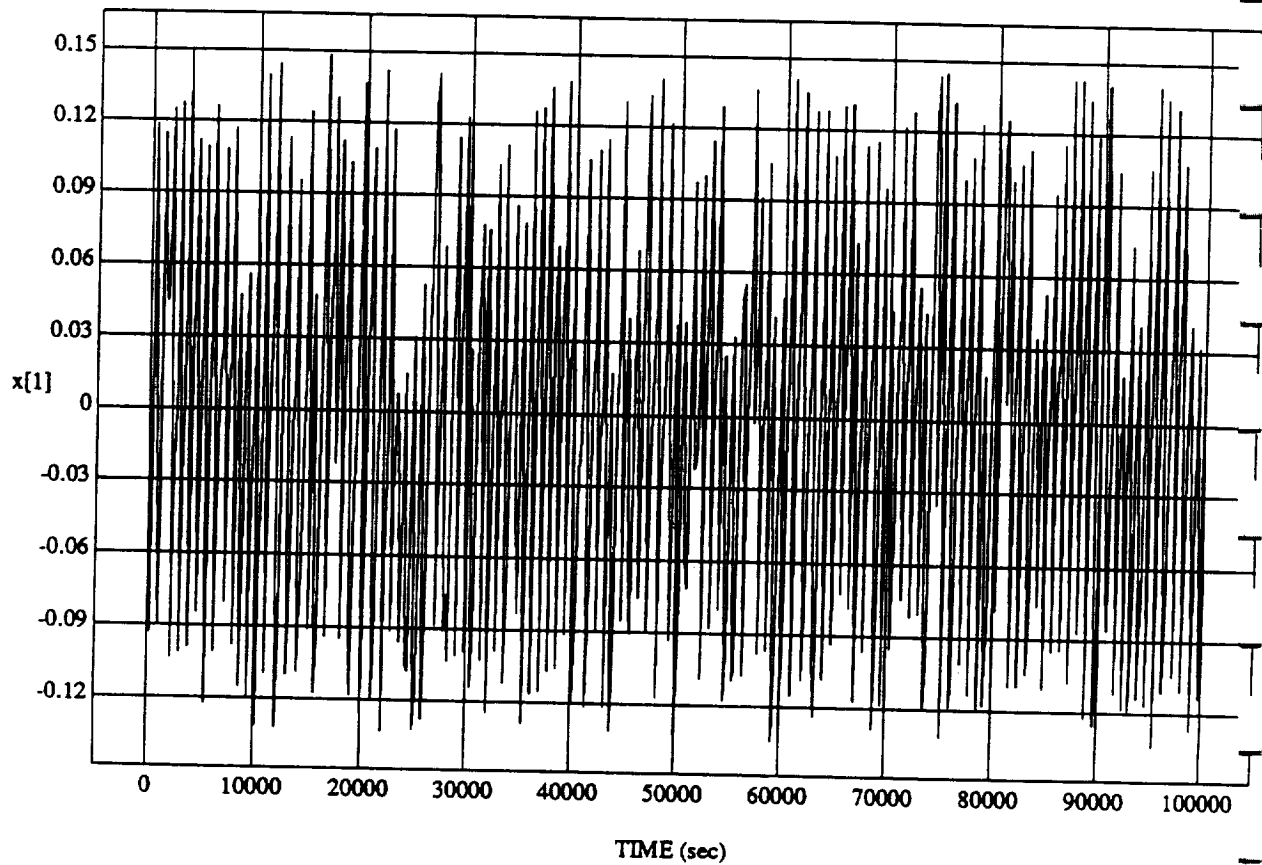
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$x[1]$  vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

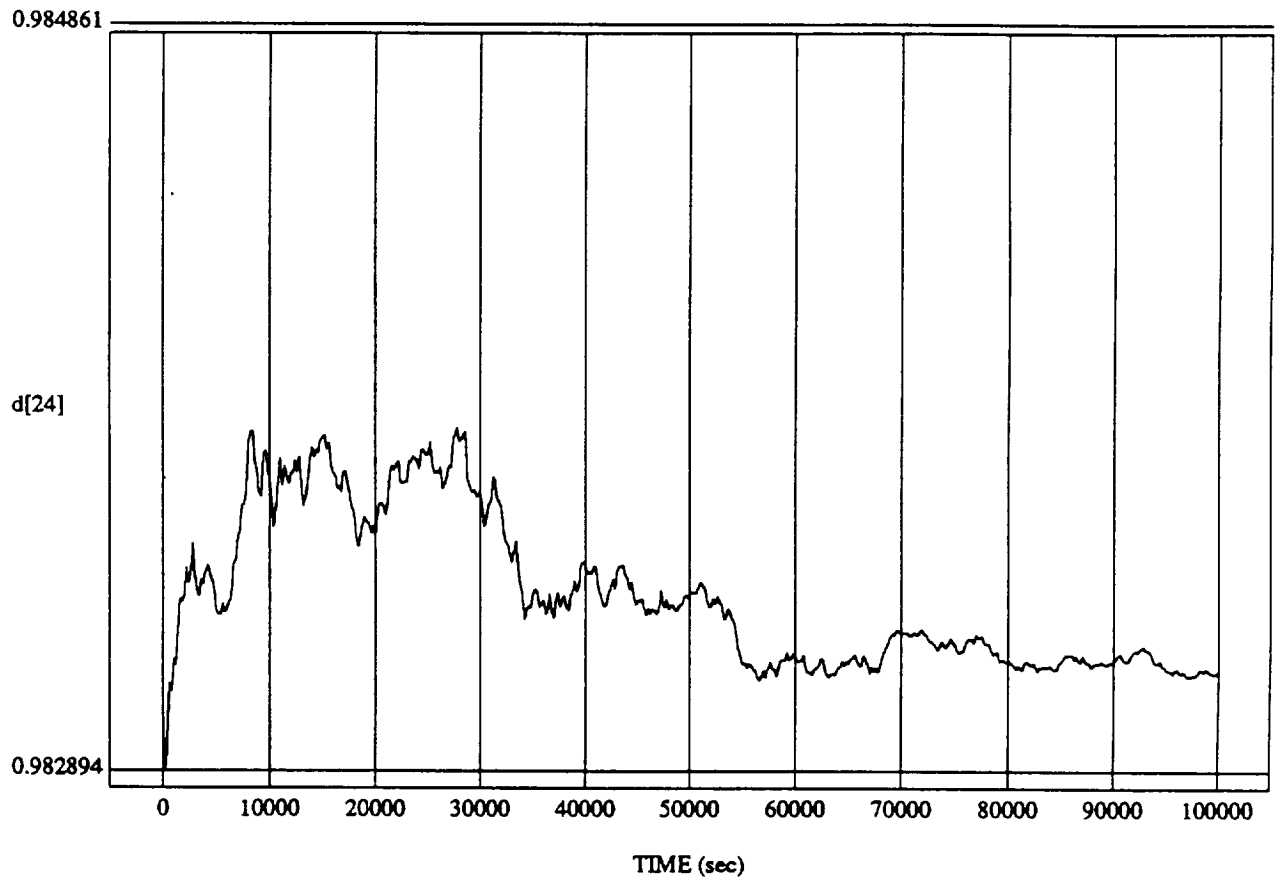


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[24] vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

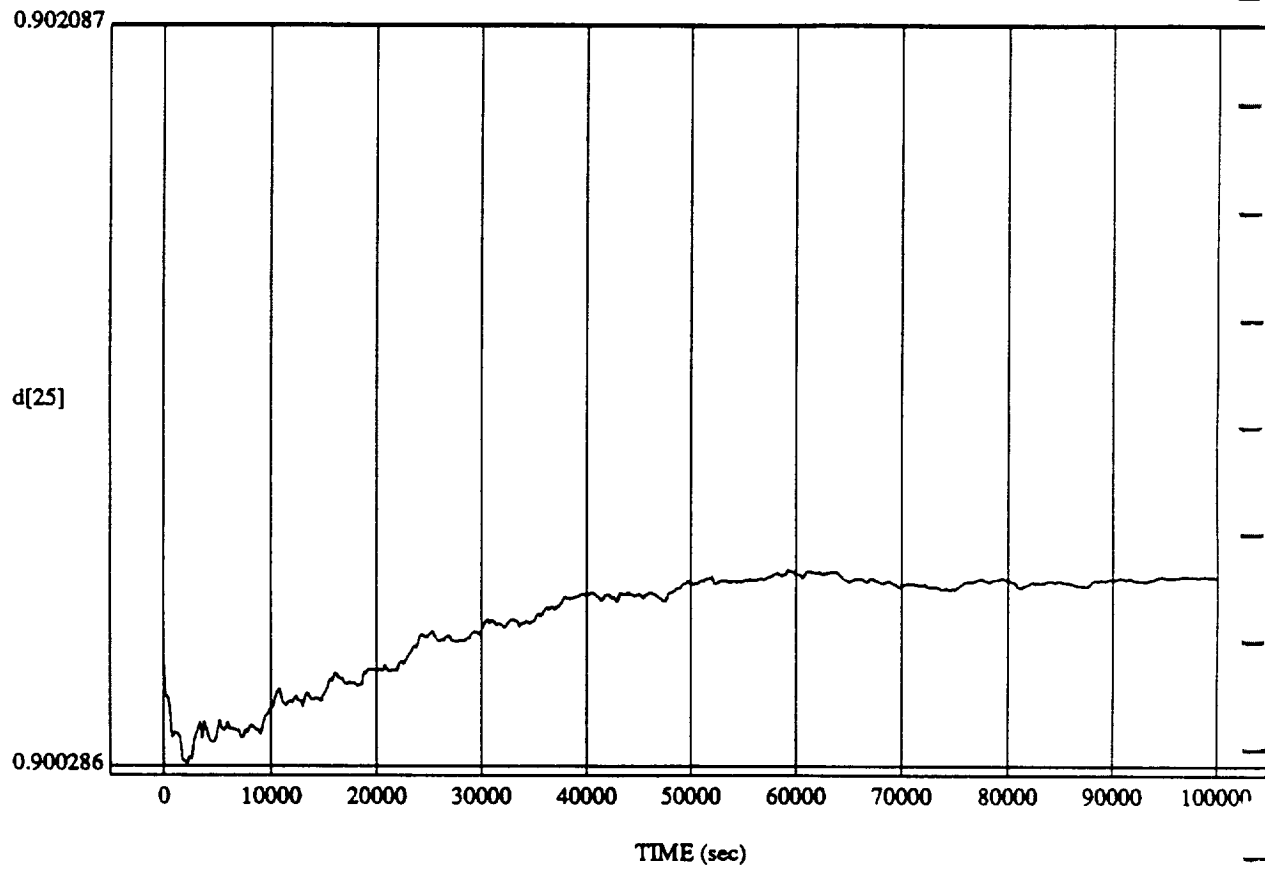


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[25] vs TIME

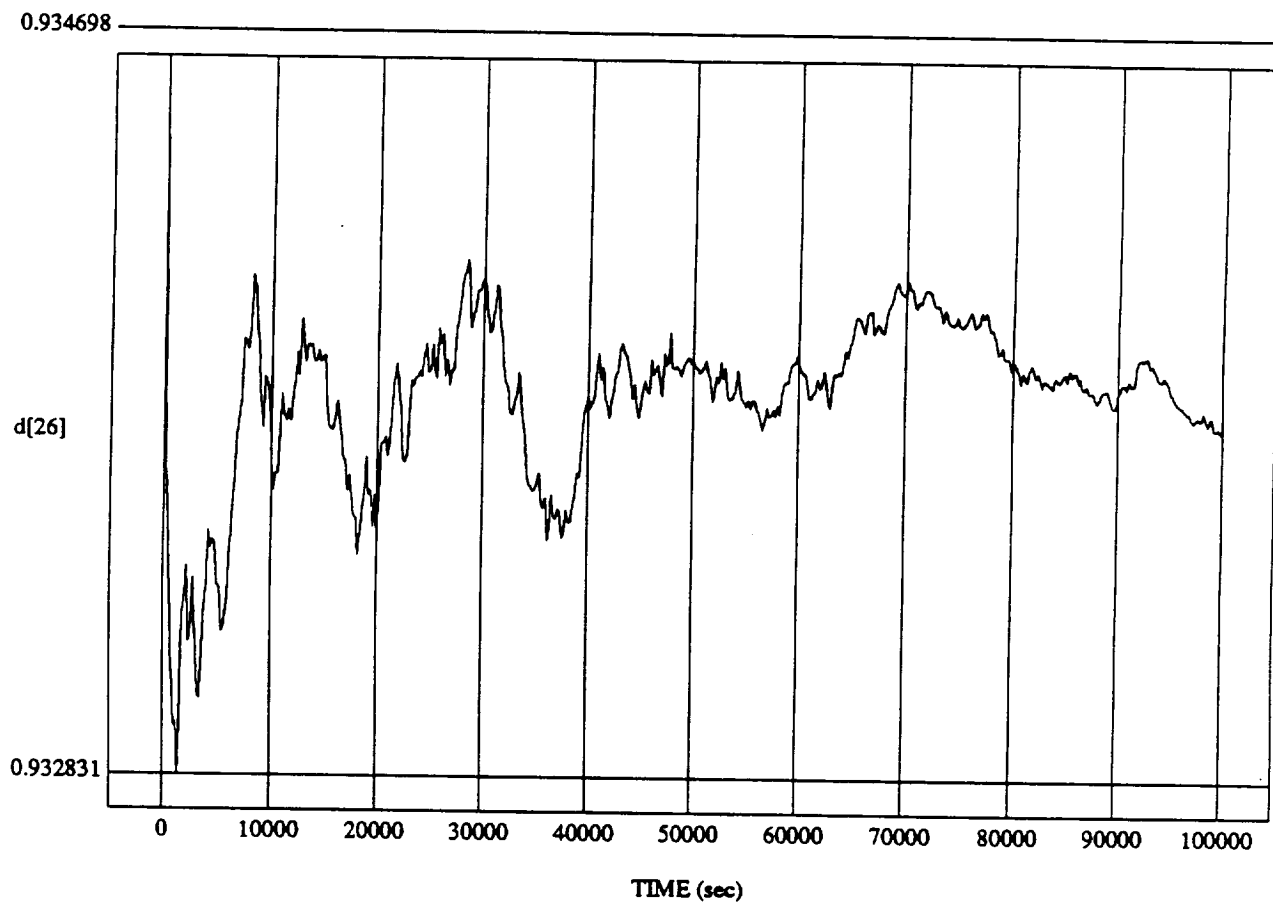
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[26] vs TIME  
RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

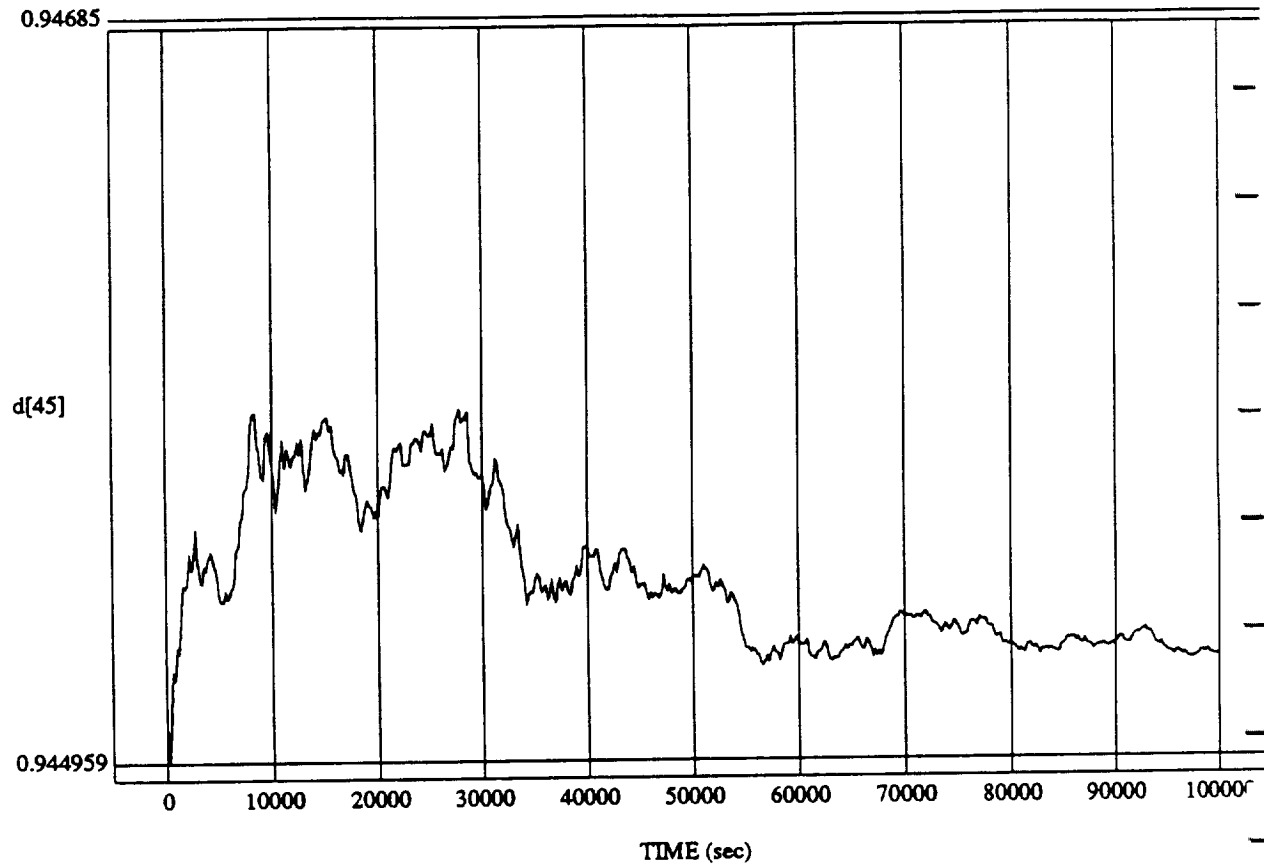


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[45] vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



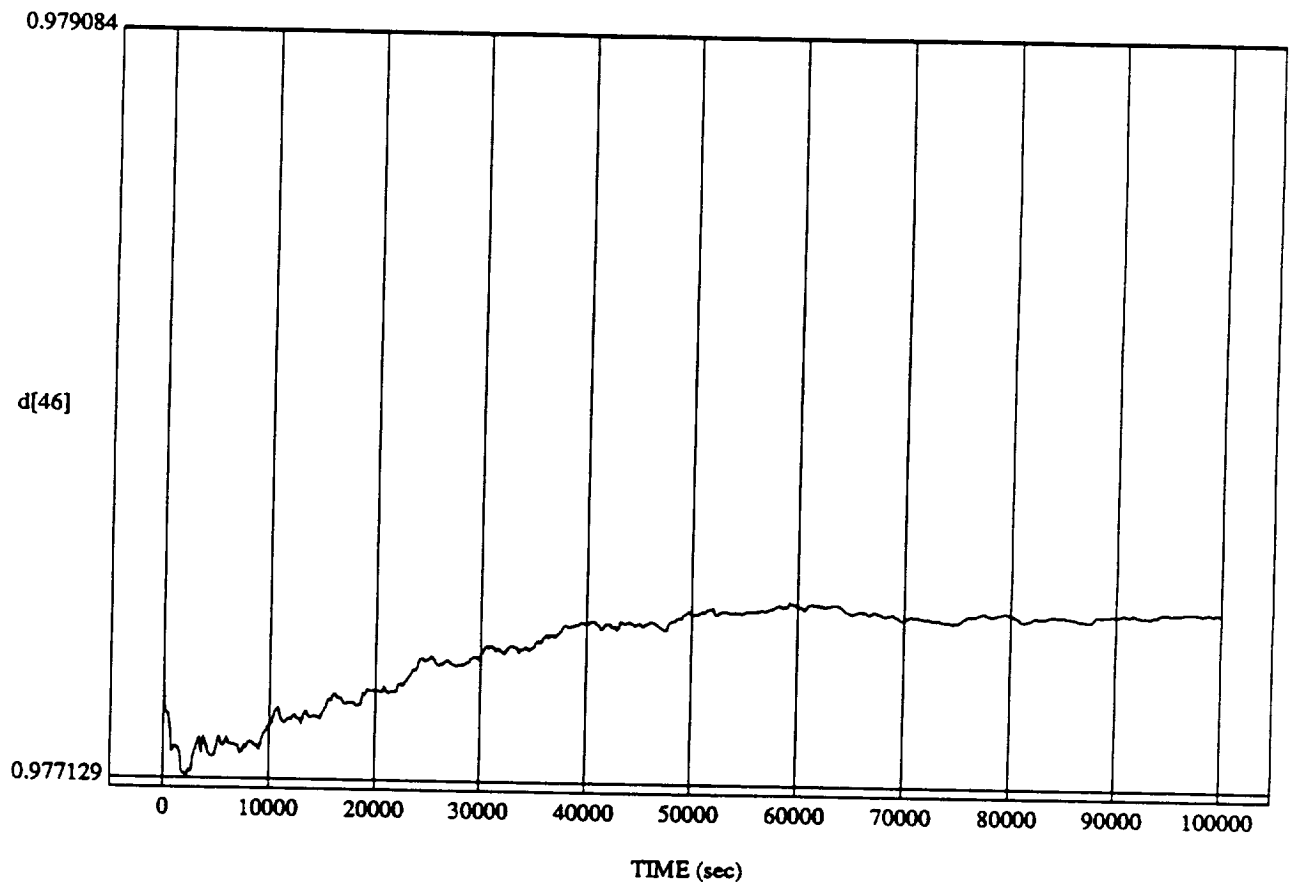
MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[46] vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

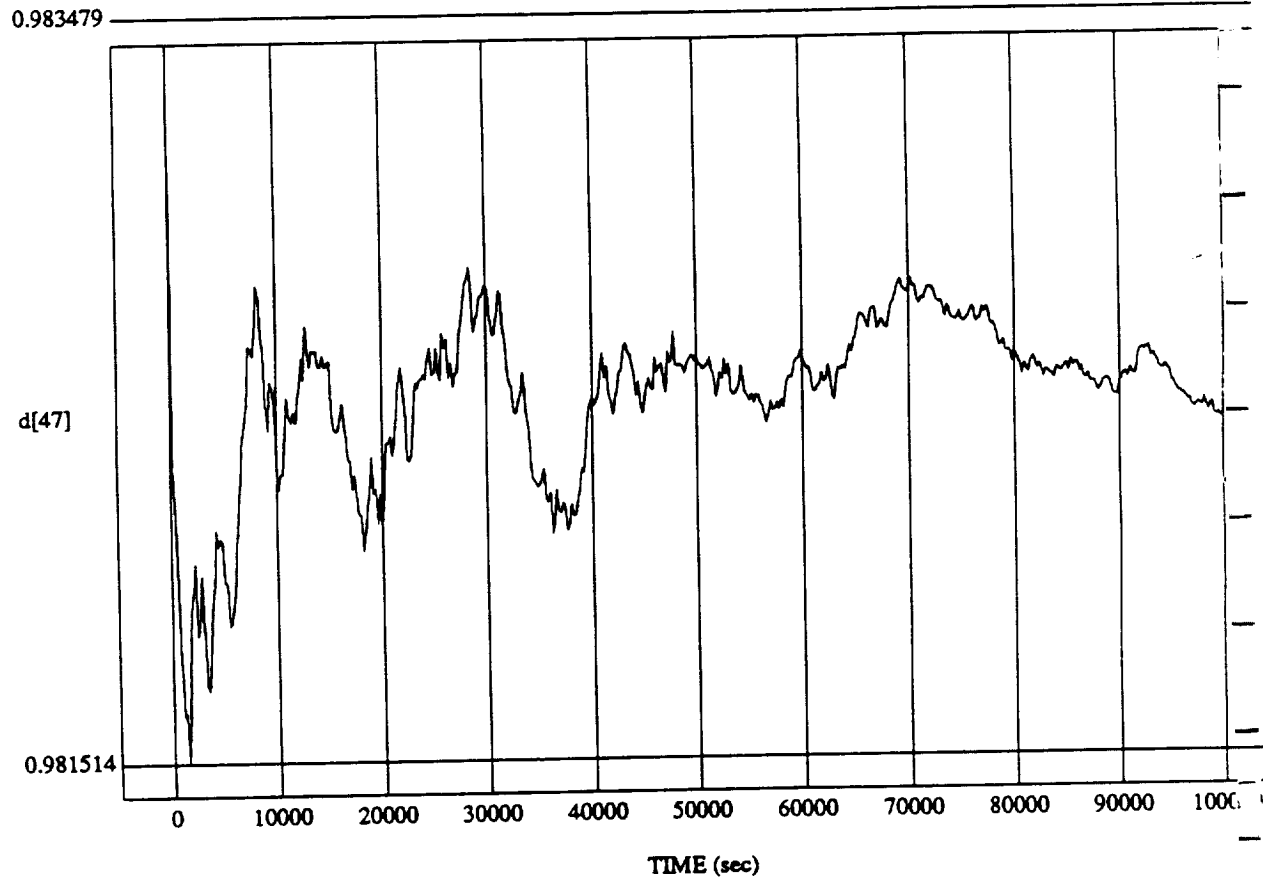


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[47] vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

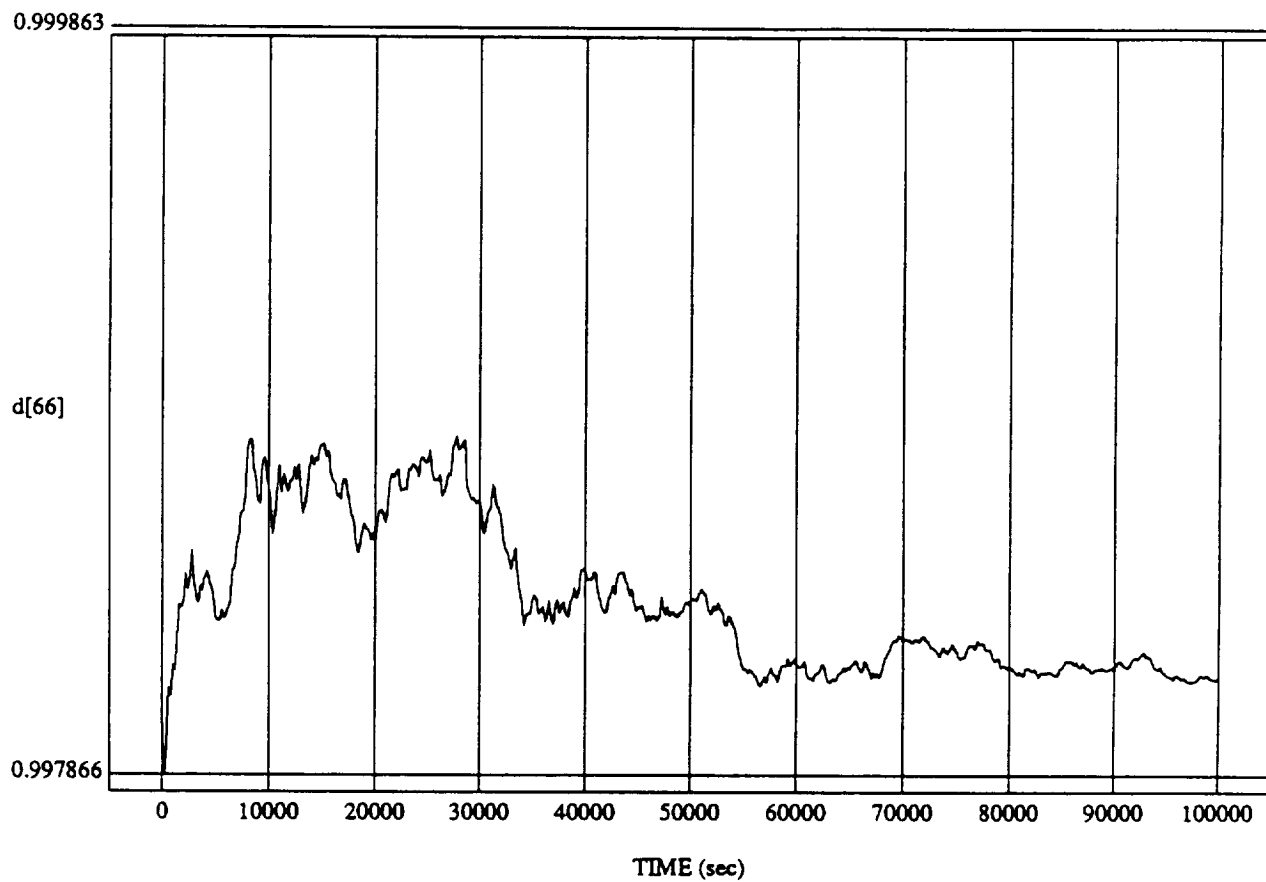


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[66] vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

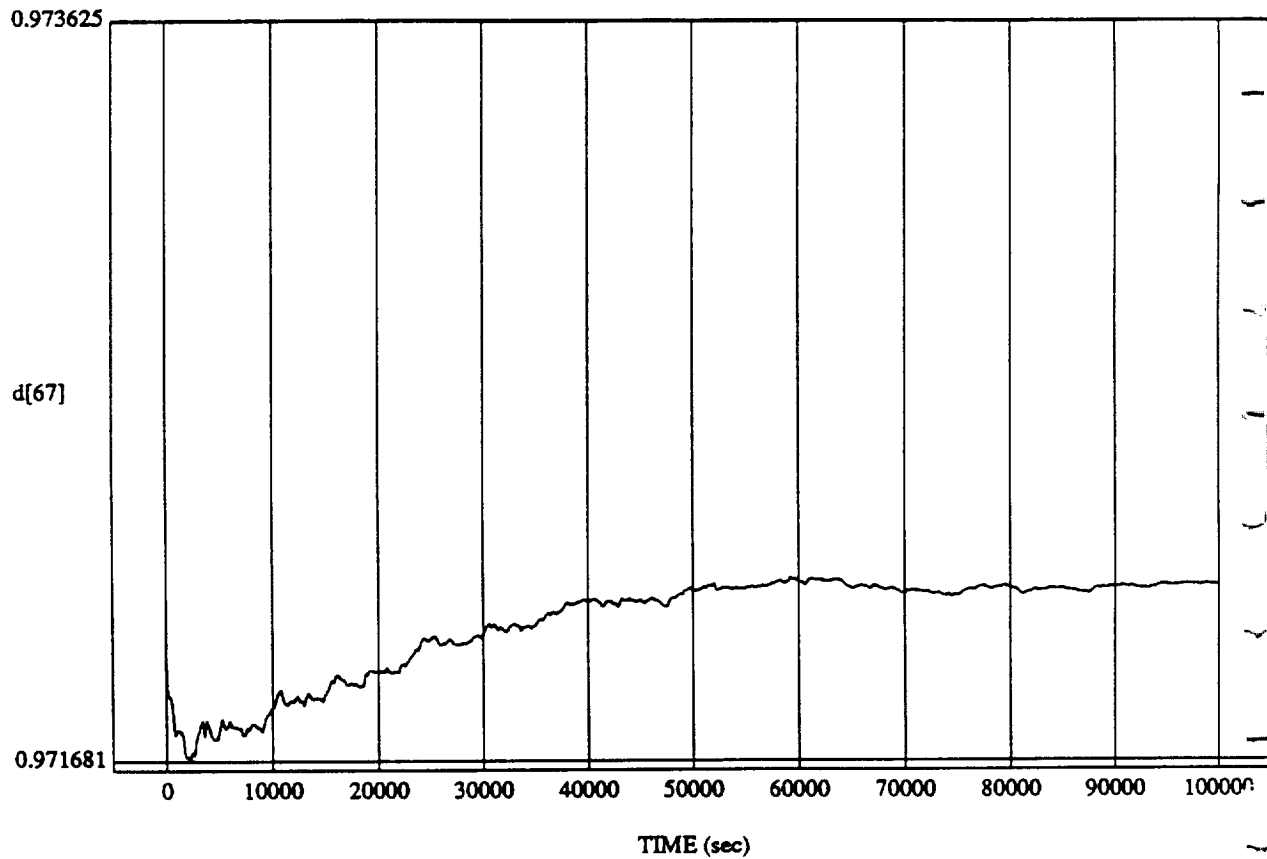


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[67] vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992

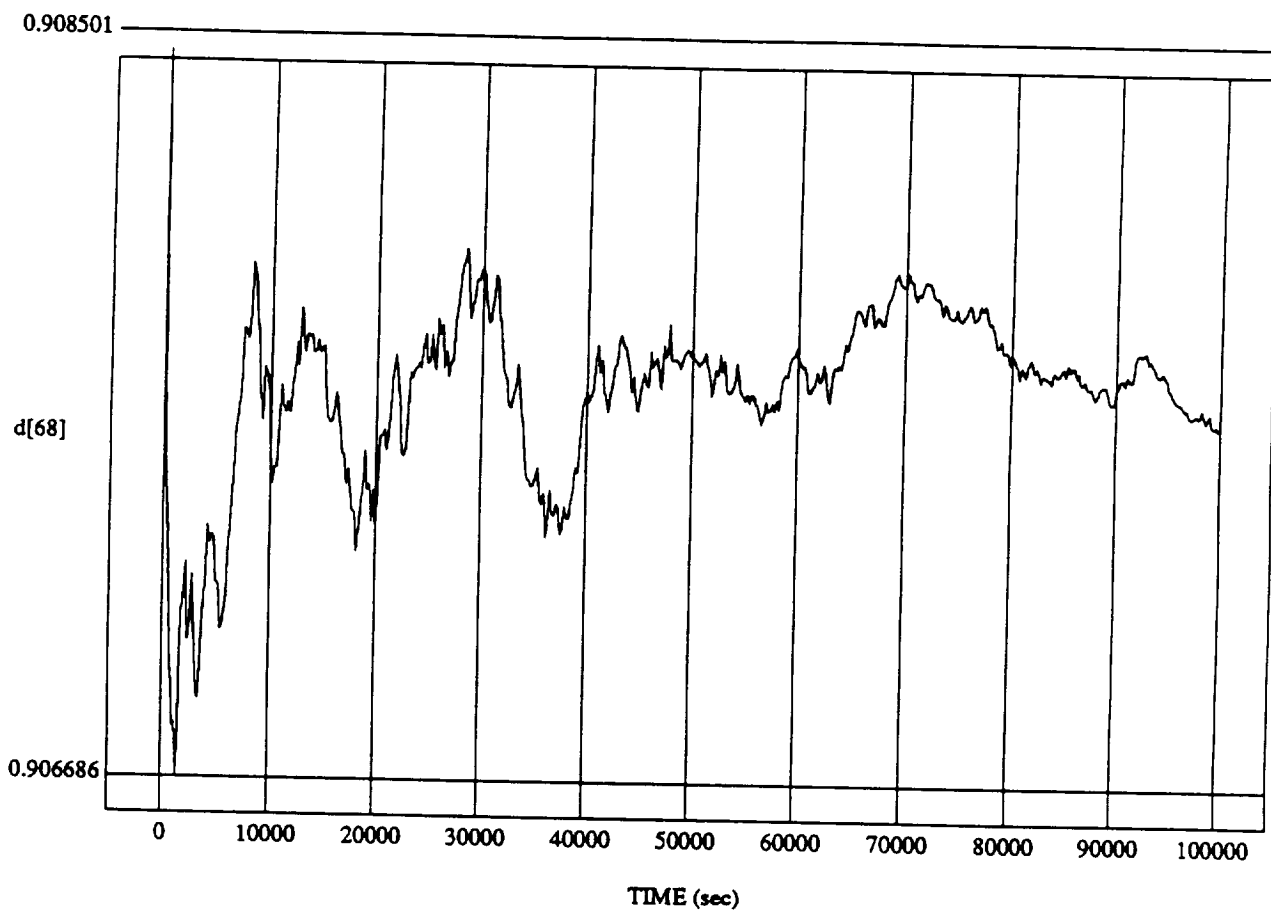


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

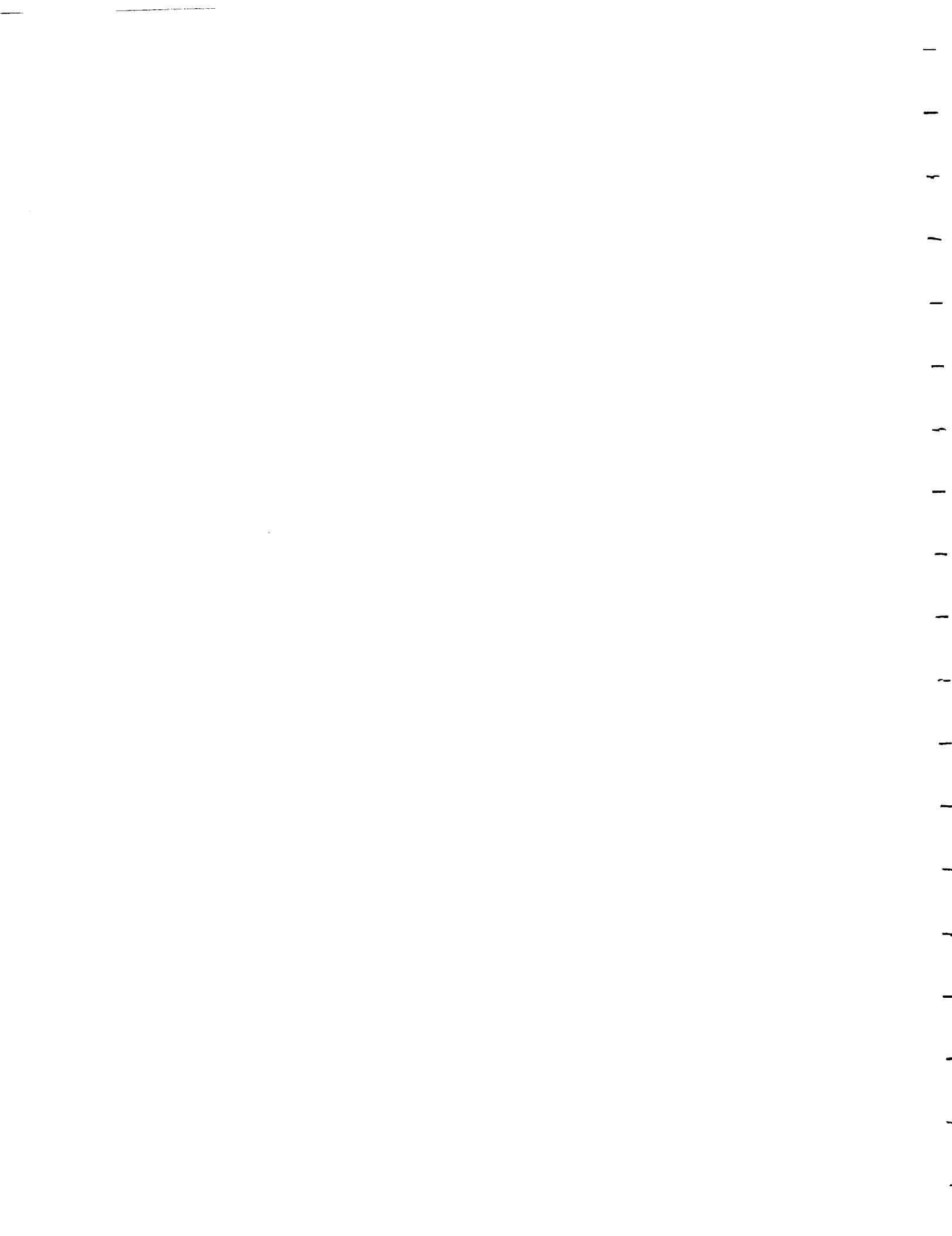
SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[68] vs TIME

RUN: Fuzzy Learner - Normalized - Learn Rate 0.1 - 23 June 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz



[illegible]

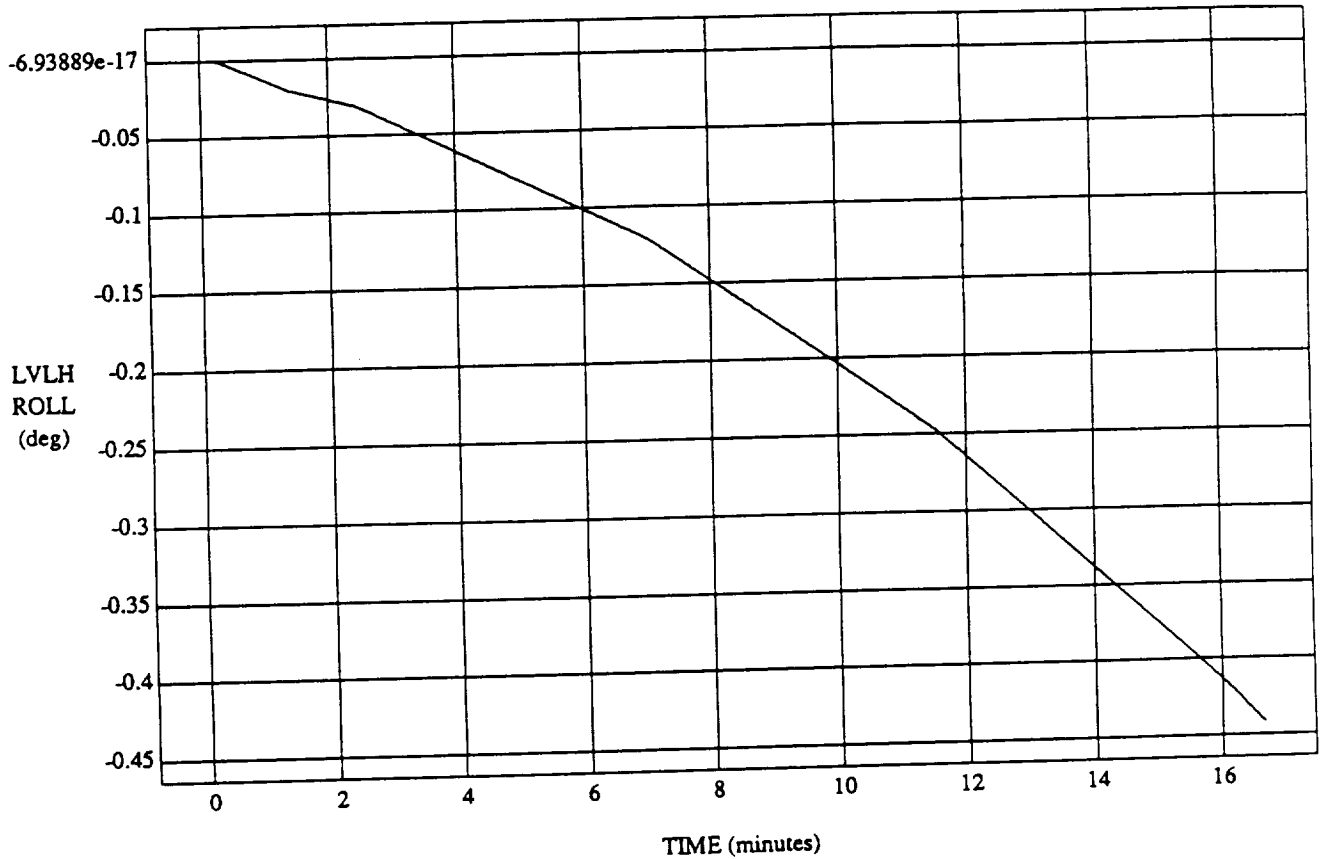




IX  
SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

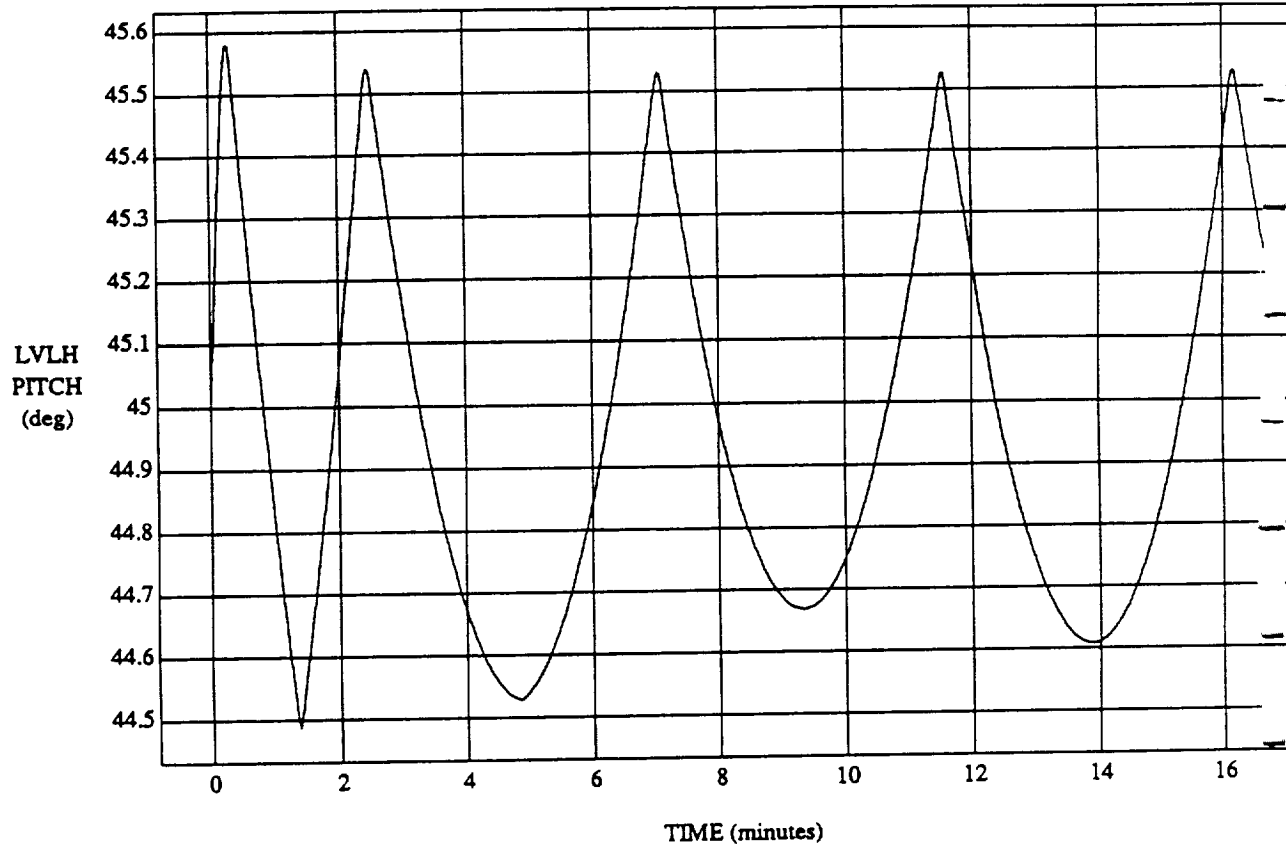
LVLH EULER PYR ROLL vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992

+ learn rate  
back to 1



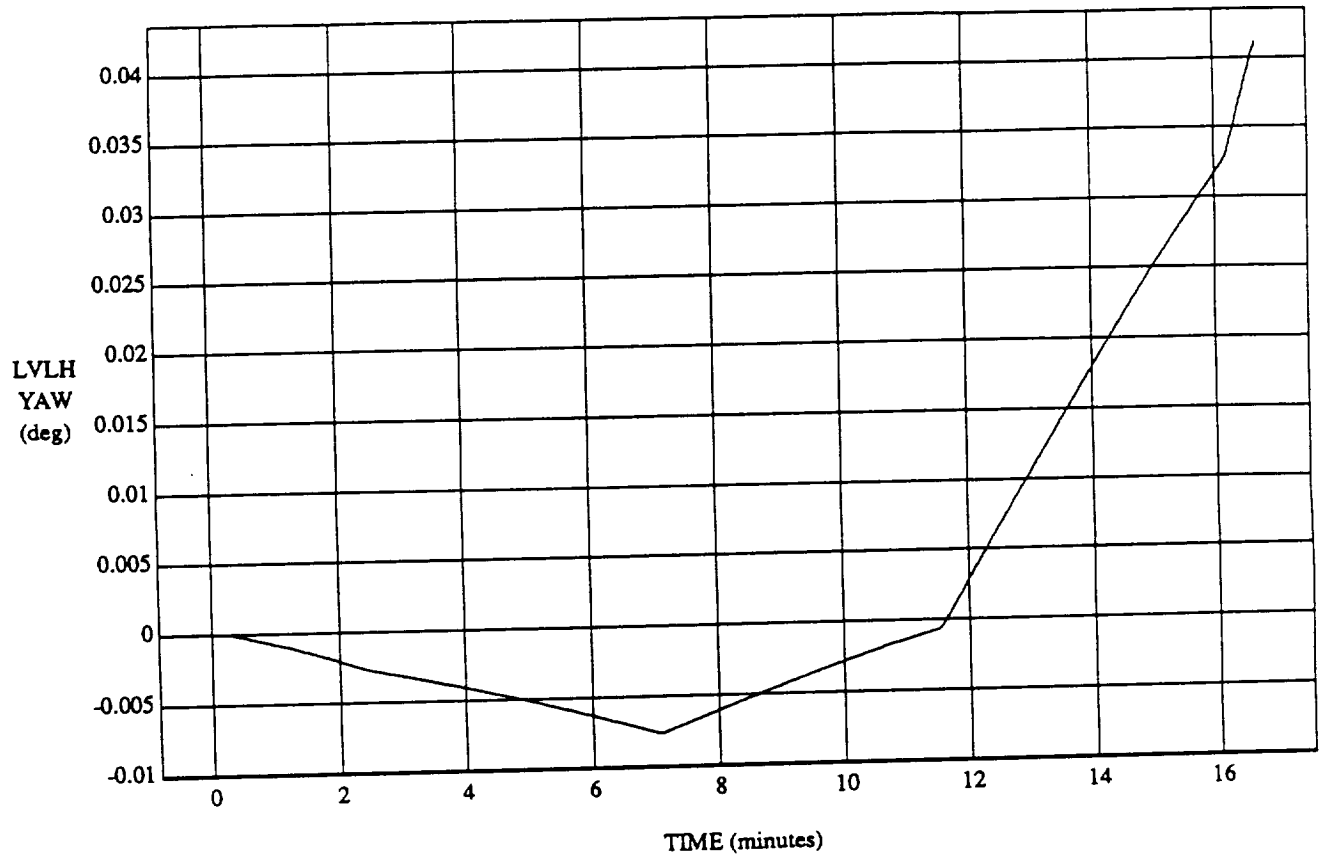
VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

LVLH EULER PYR PITCH vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

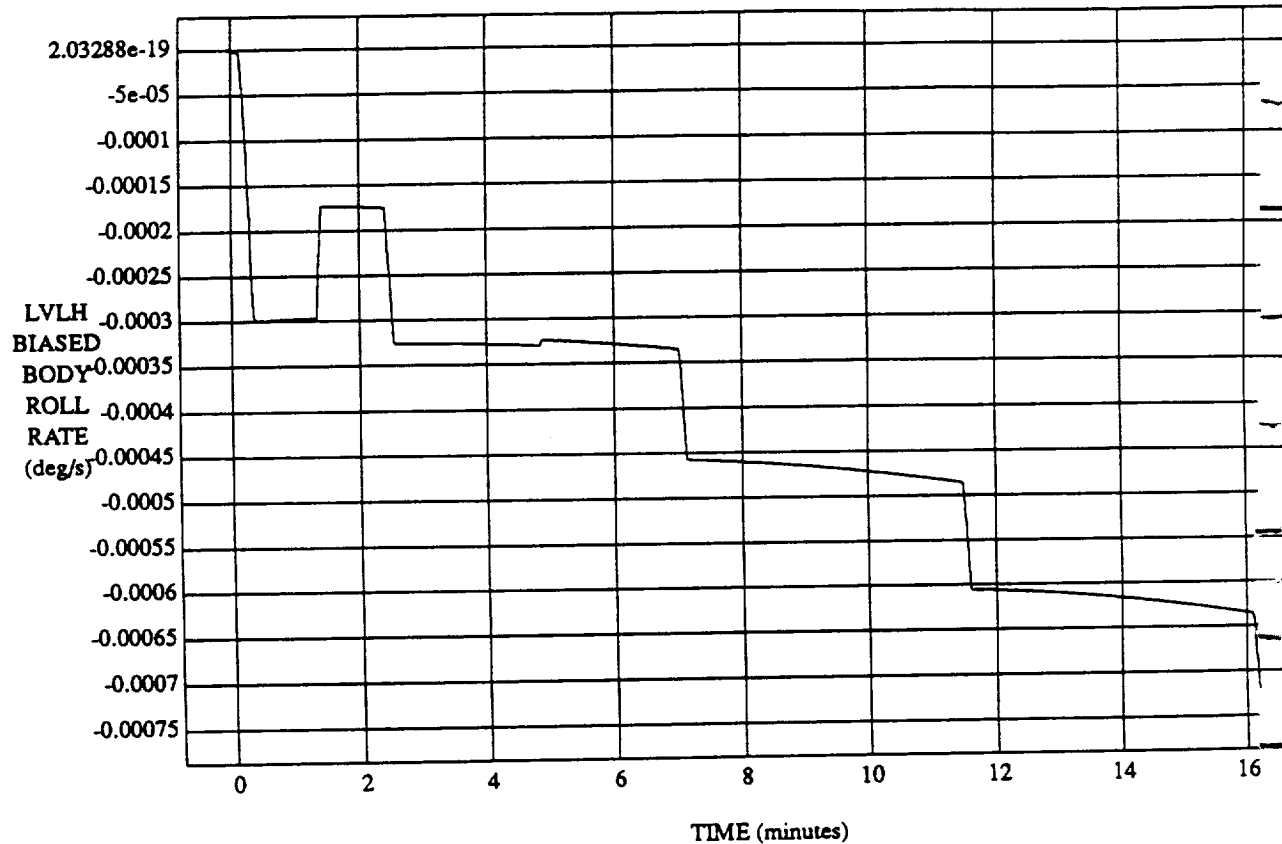
LVLH EULER PYR YAW vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

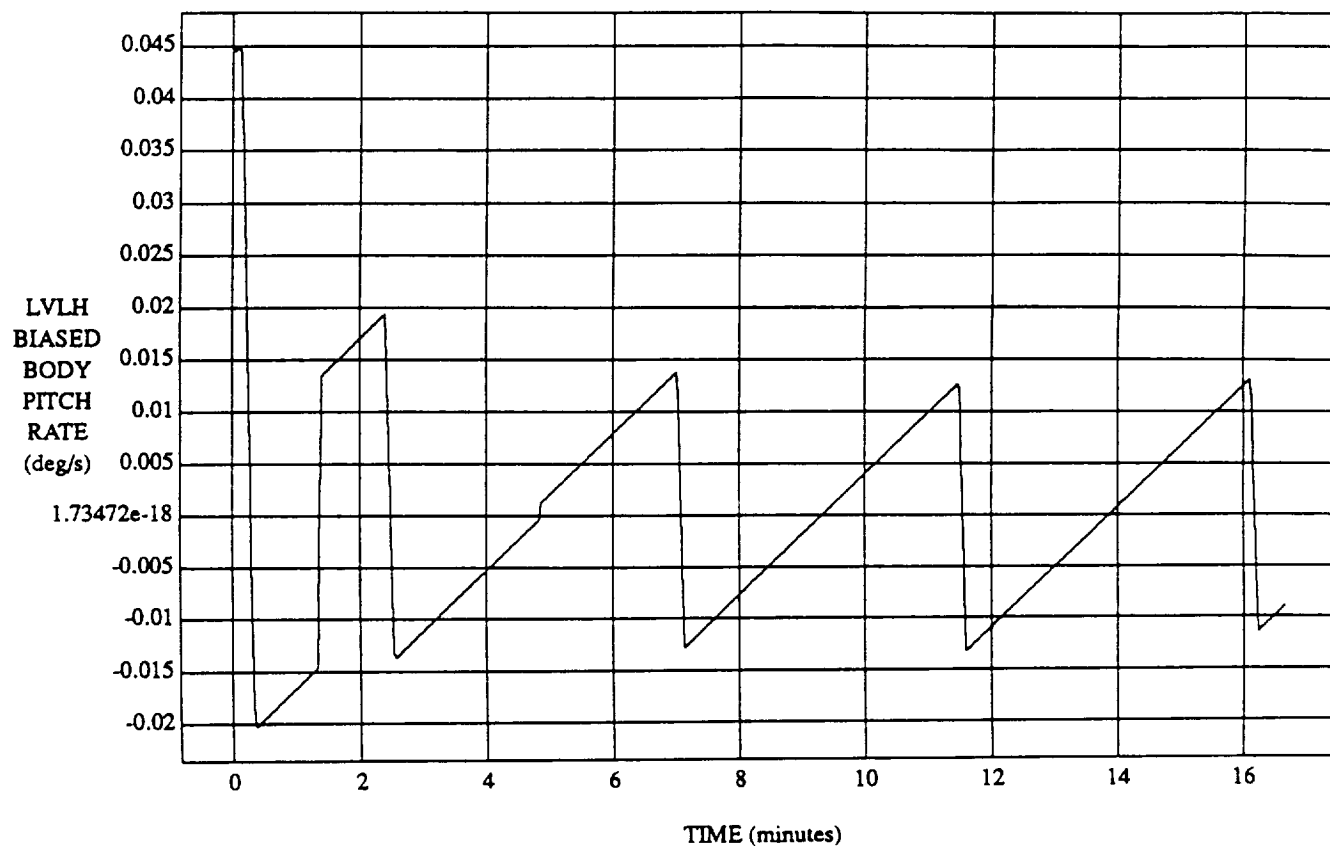
# LVLH BIASED BODY ROLL RATE vs TIME

RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

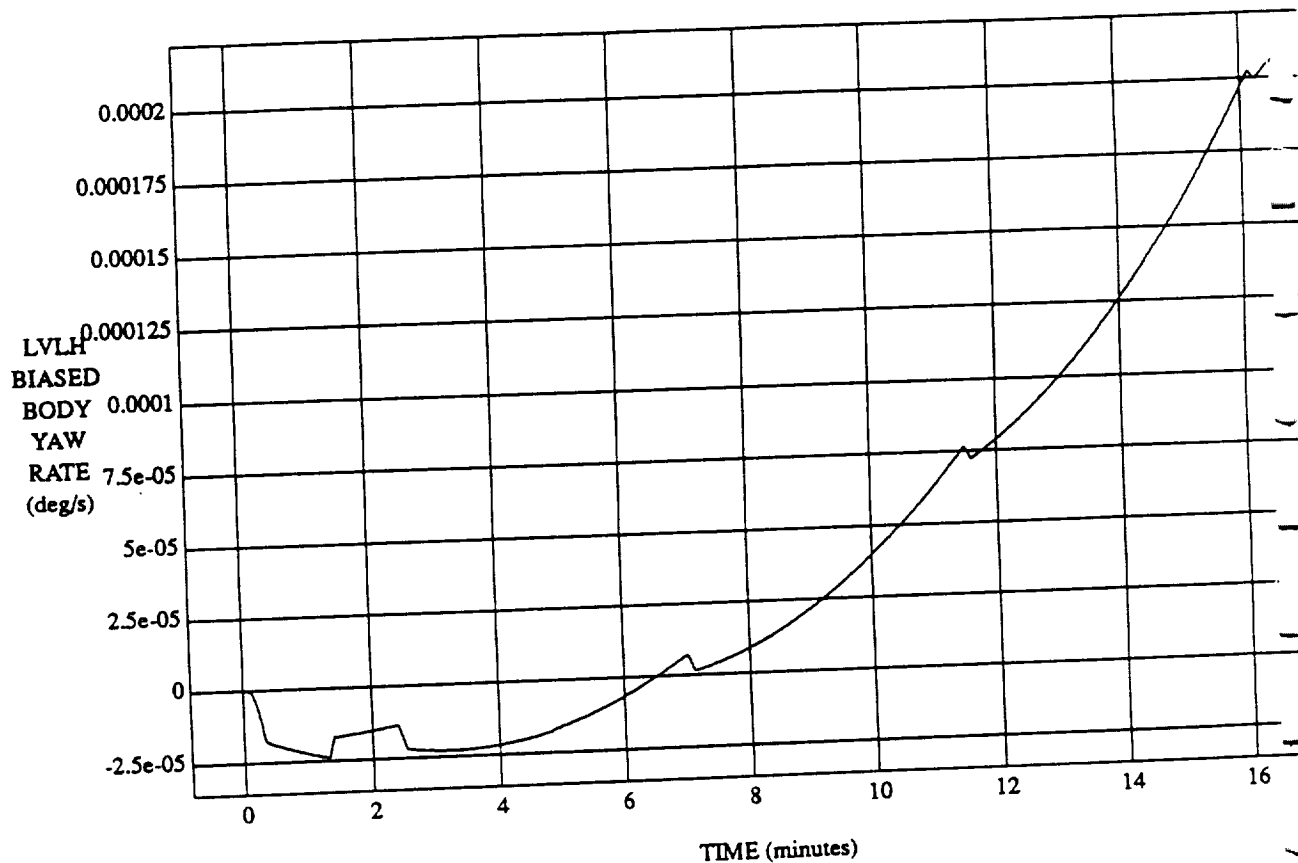
LVLH BIASED BODY PITCH RATE vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH BIASED BODY YAW RATE vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992

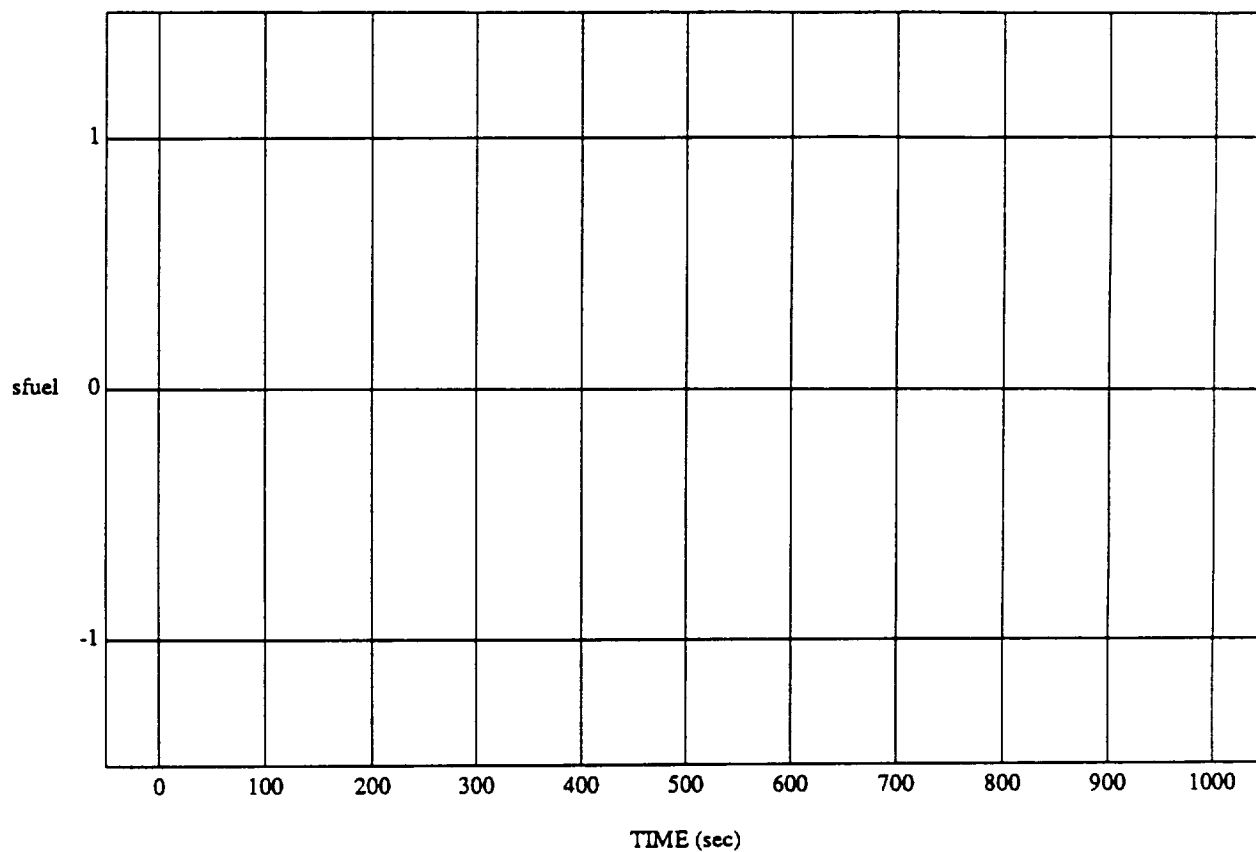


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME

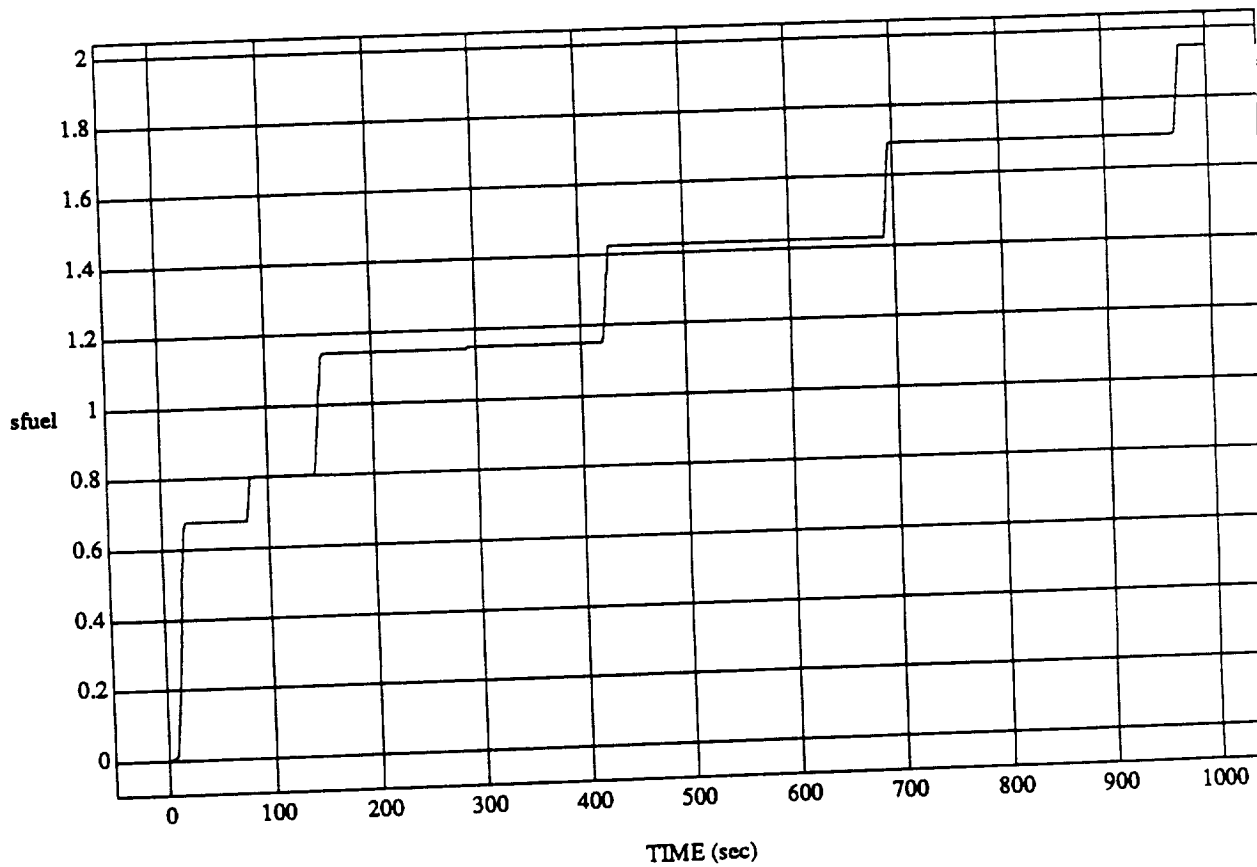
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.primary  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992

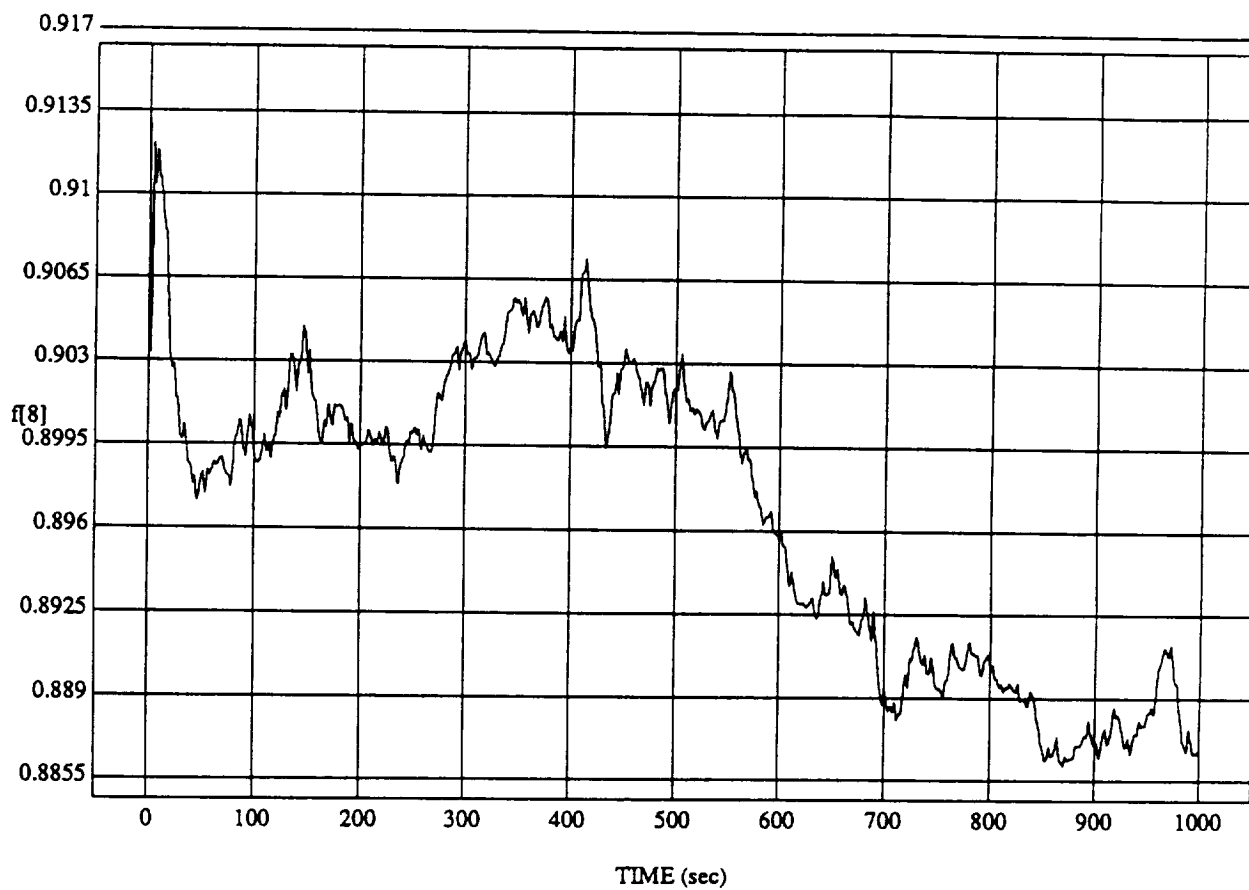


MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[8]$  vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992

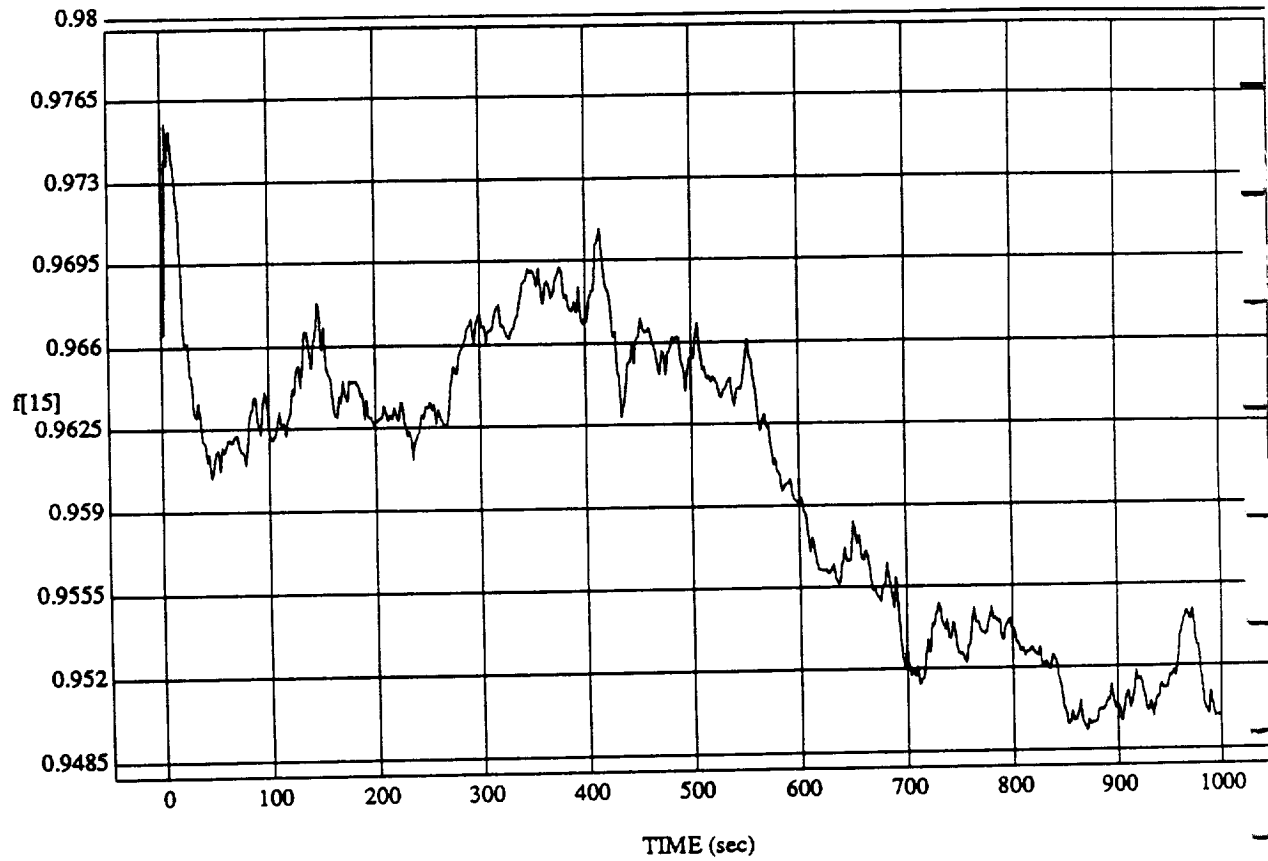


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[15] vs TIME

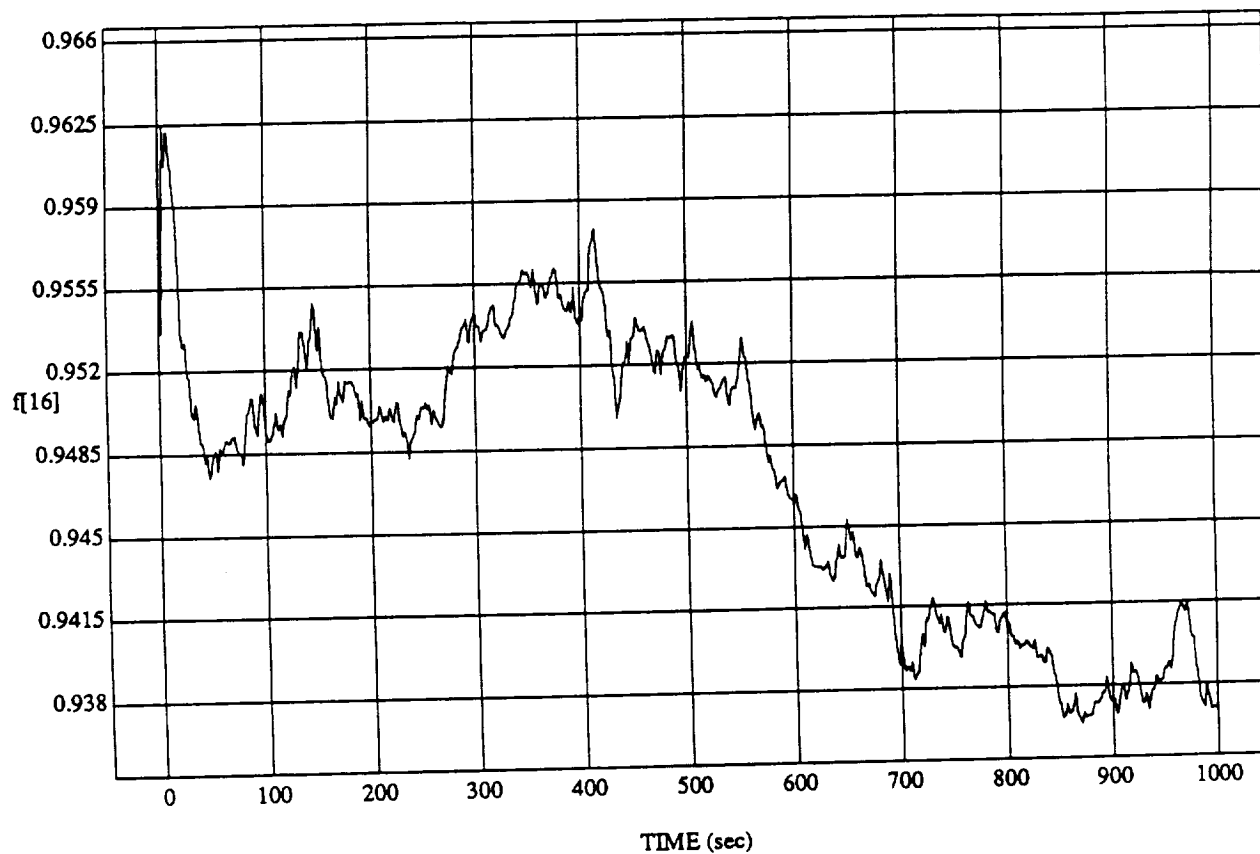
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[16]$  vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992

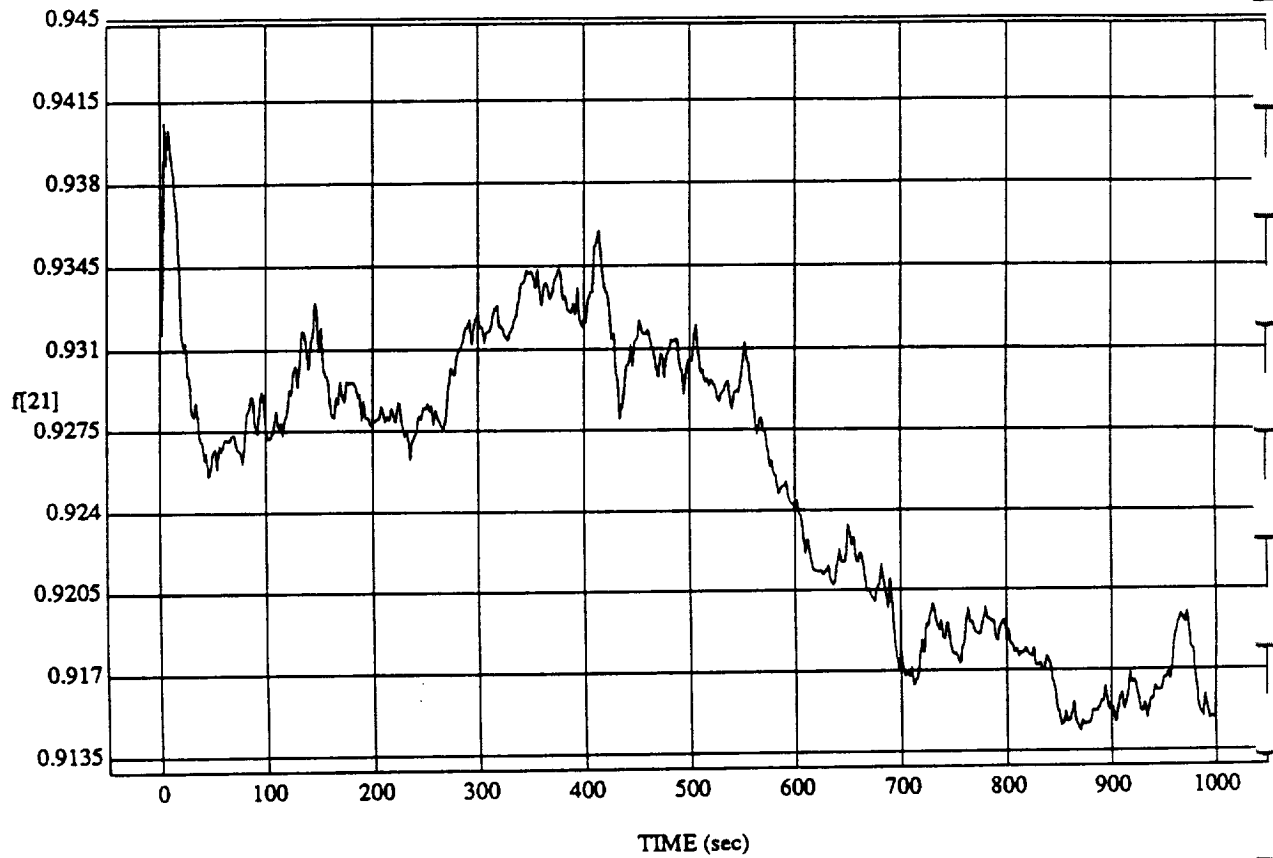


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[21] vs TIME

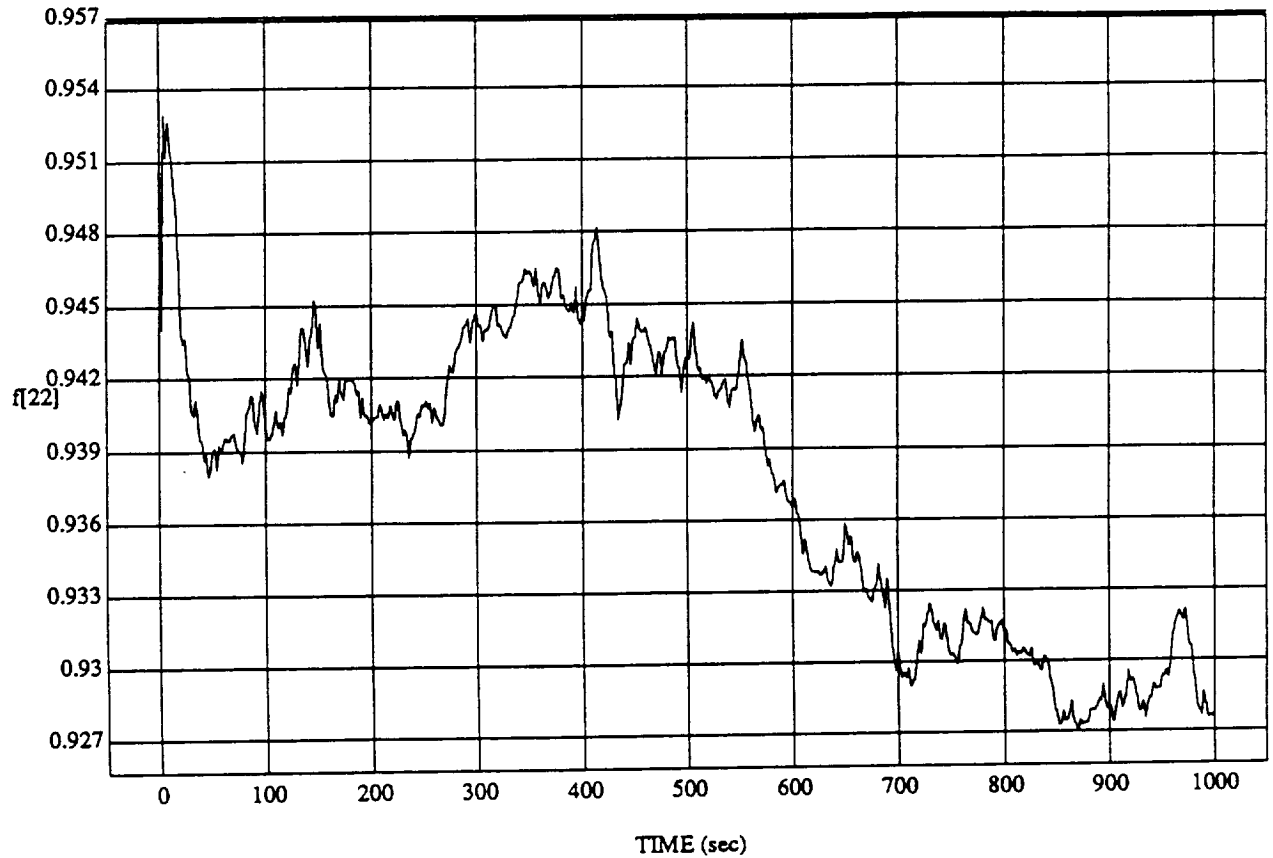
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

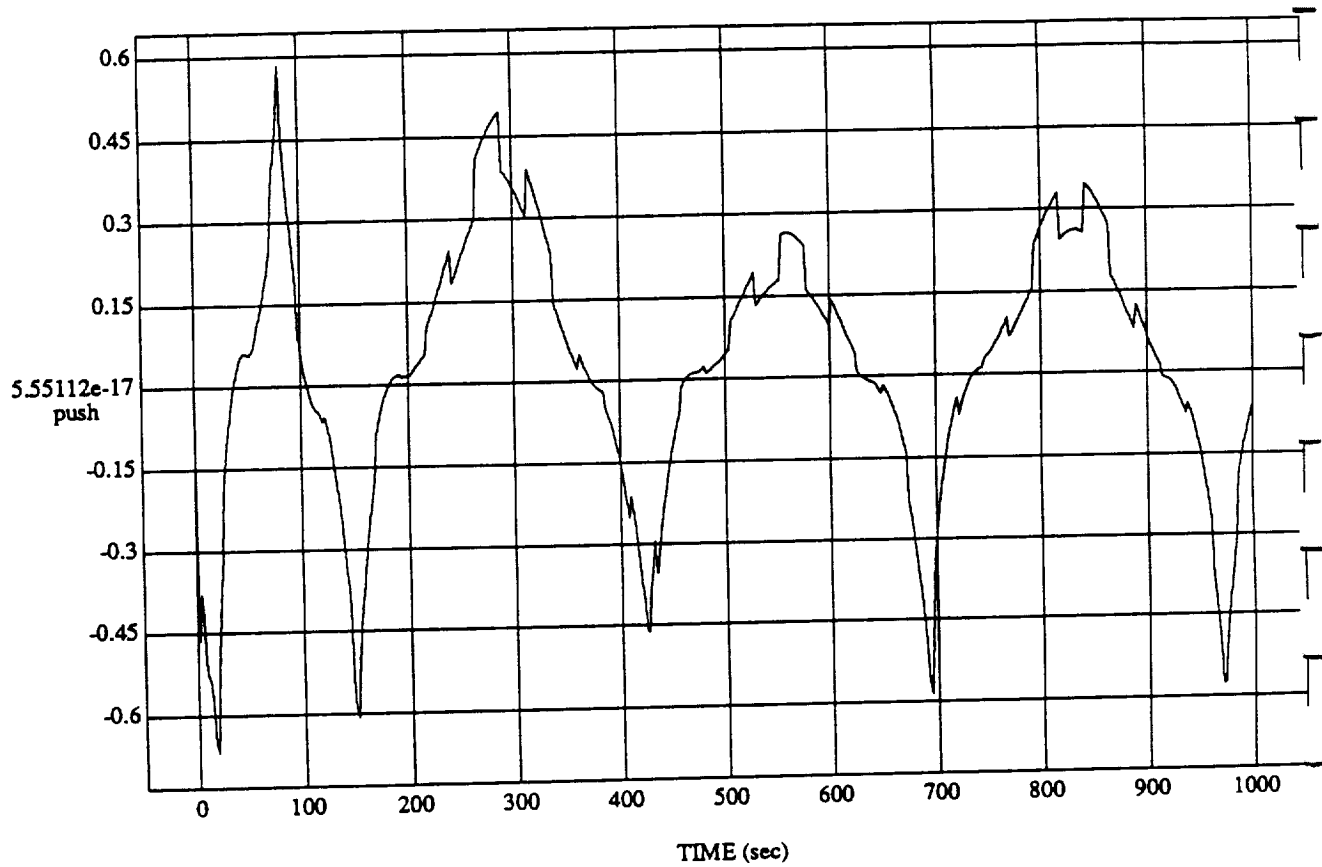
$f[22]$  vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

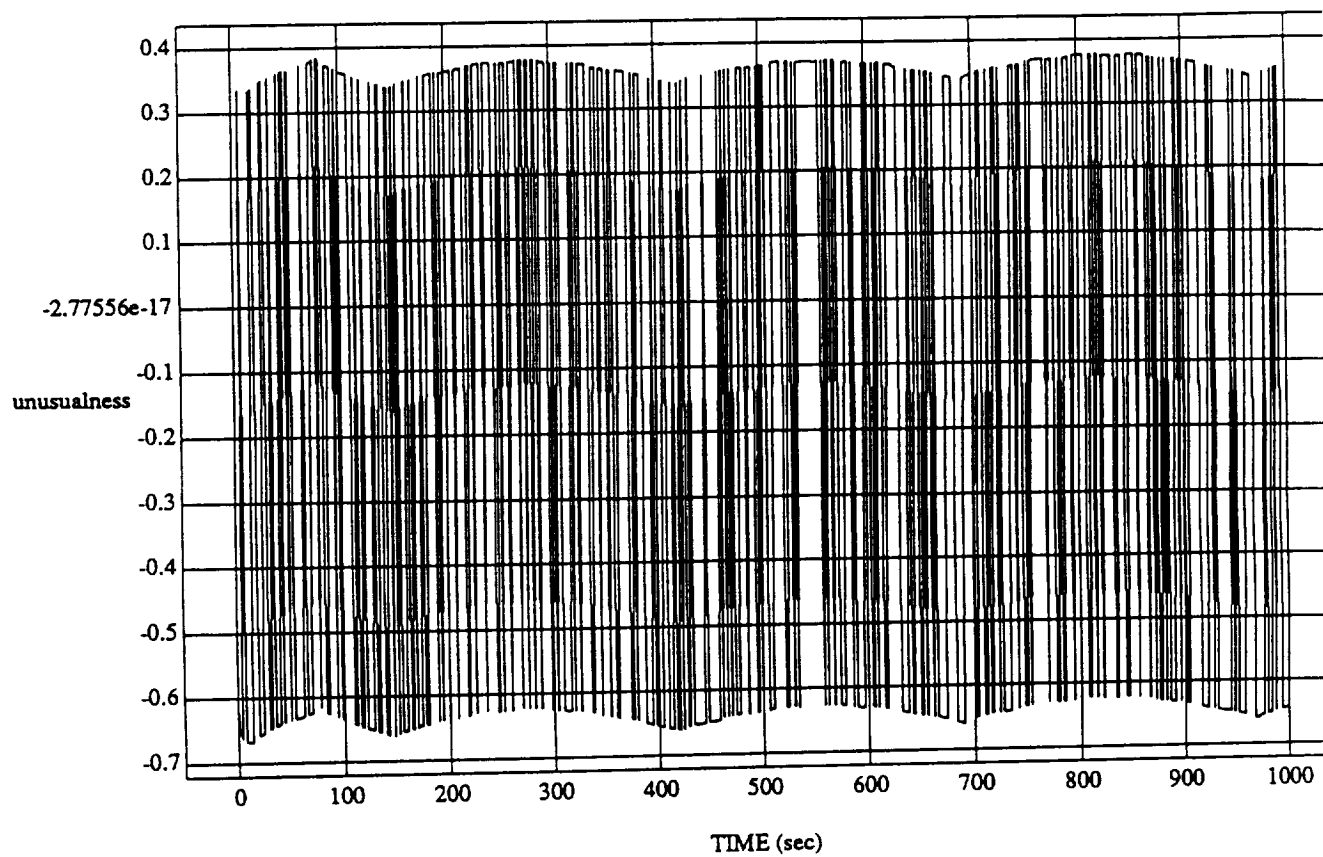
push vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

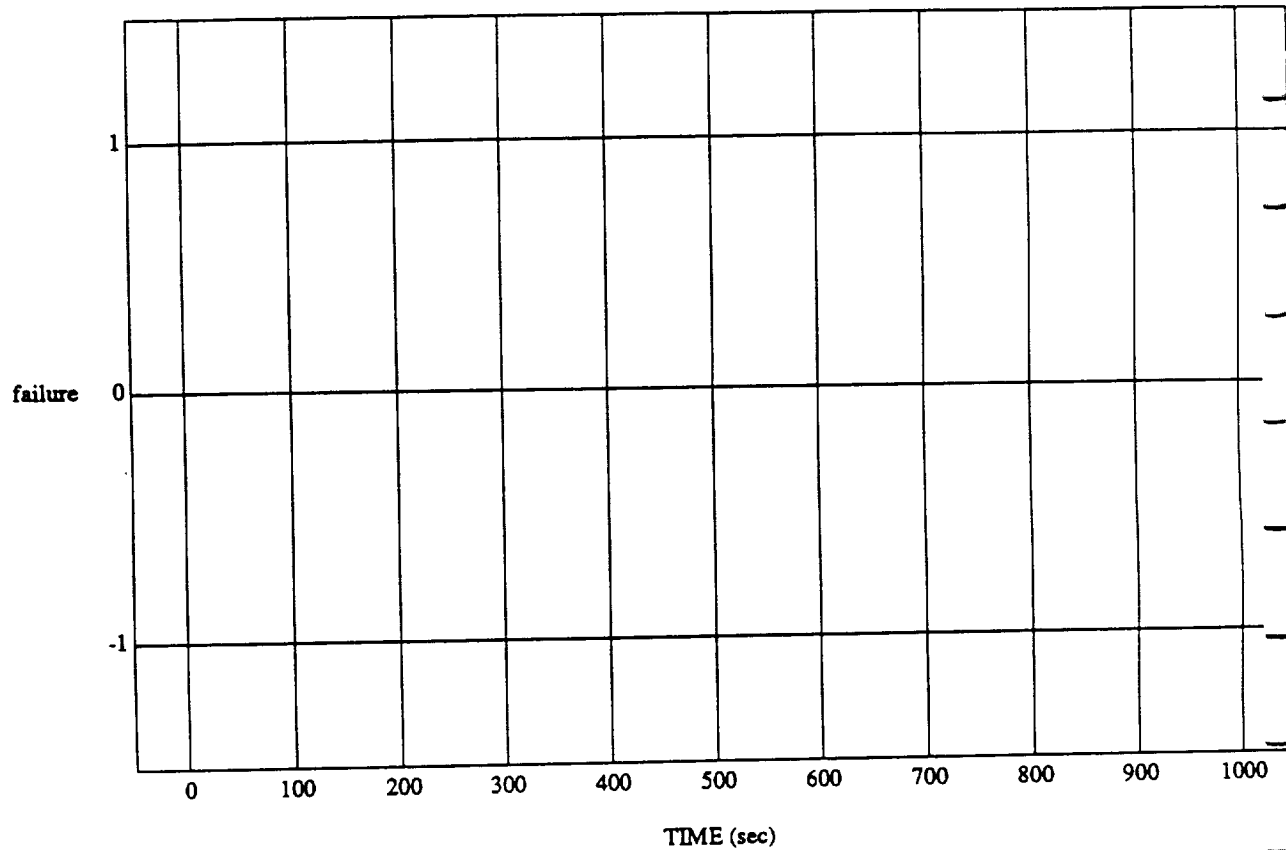
unusualness vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

failure vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992

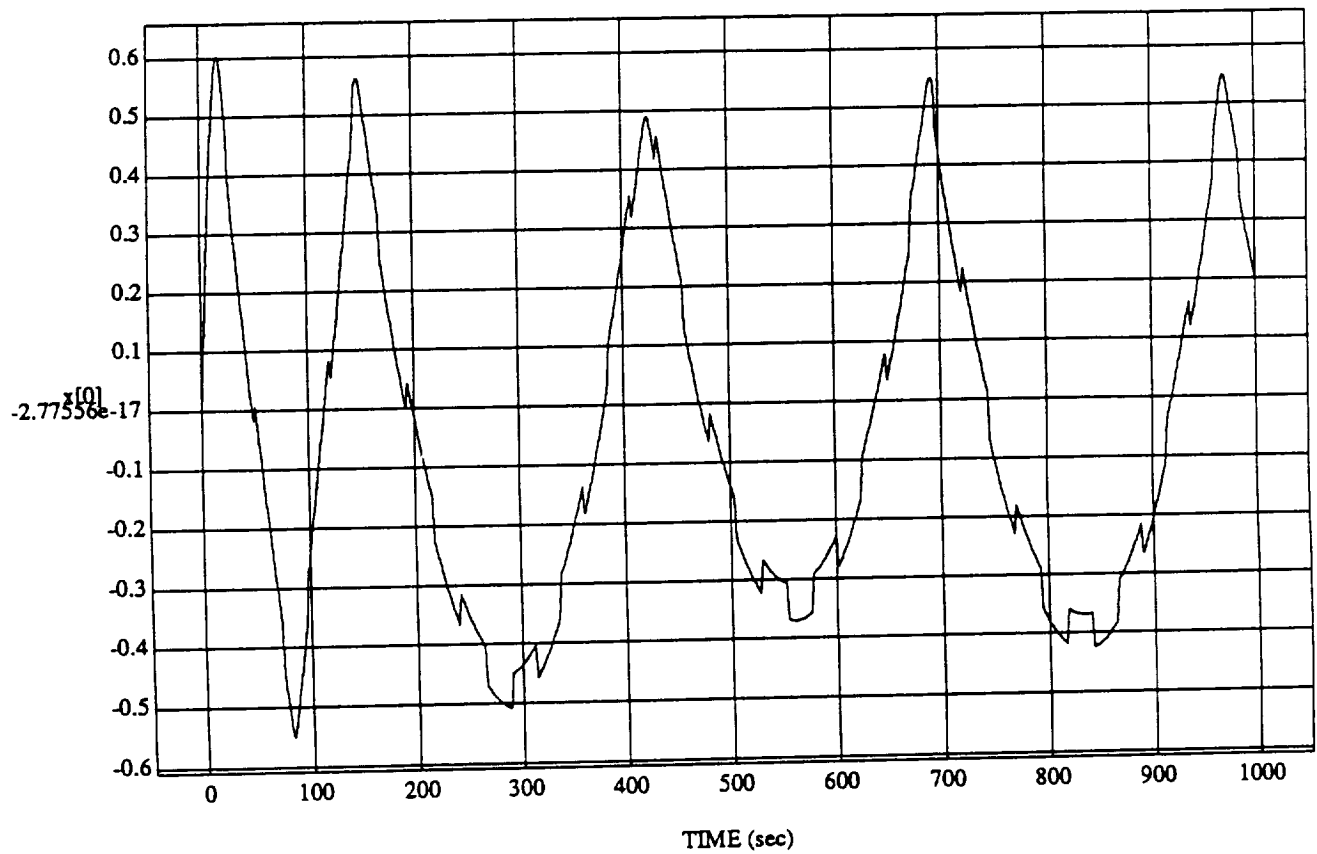


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

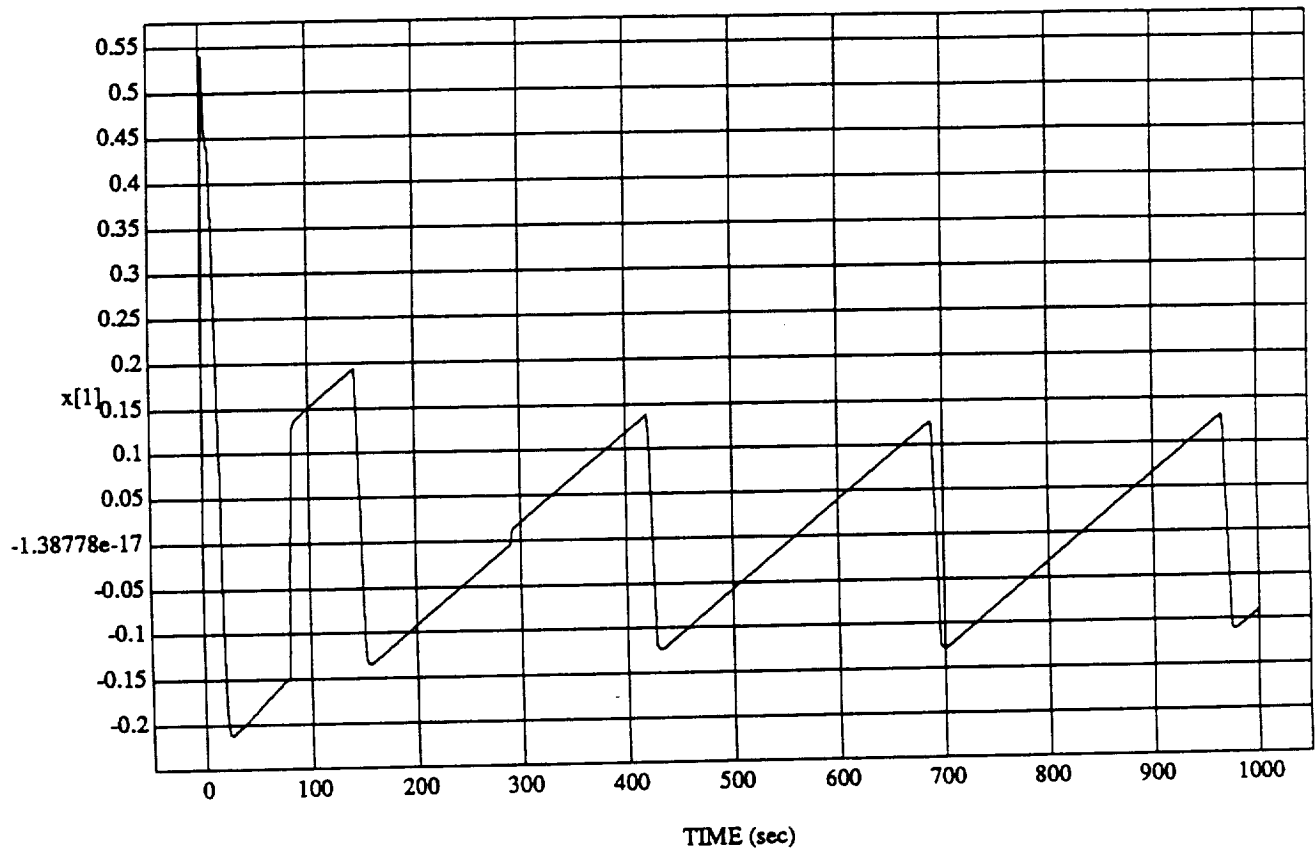
$x[0]$  vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

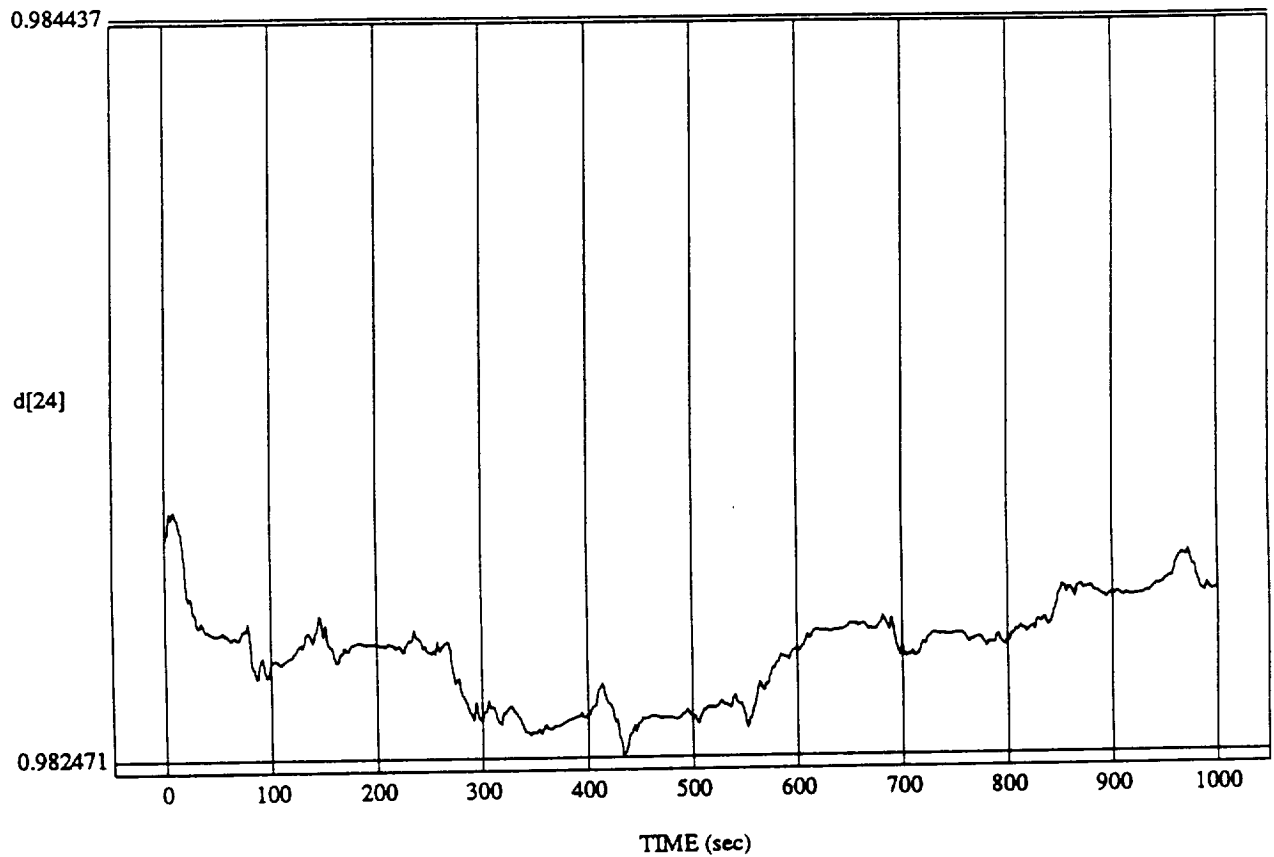
$x[1]$  vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

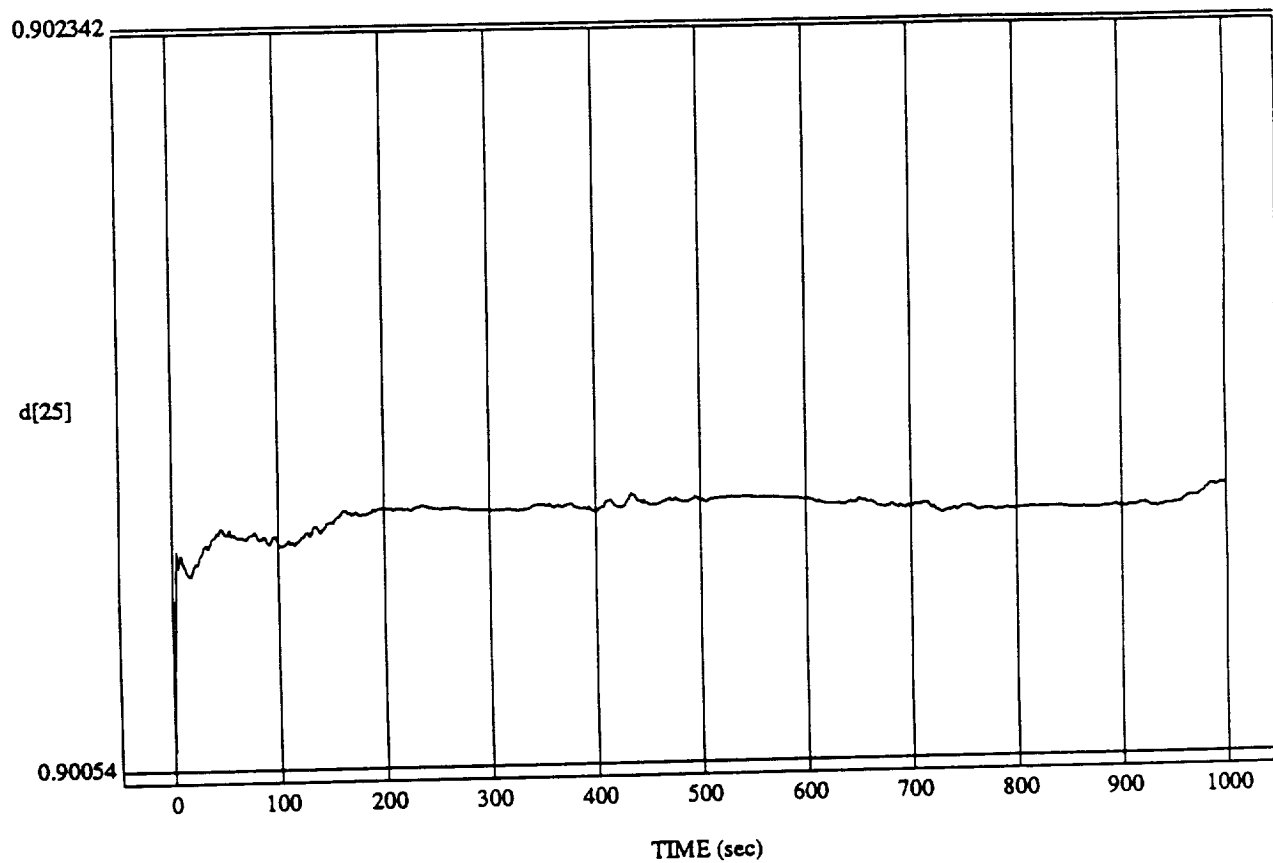
d[24] vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

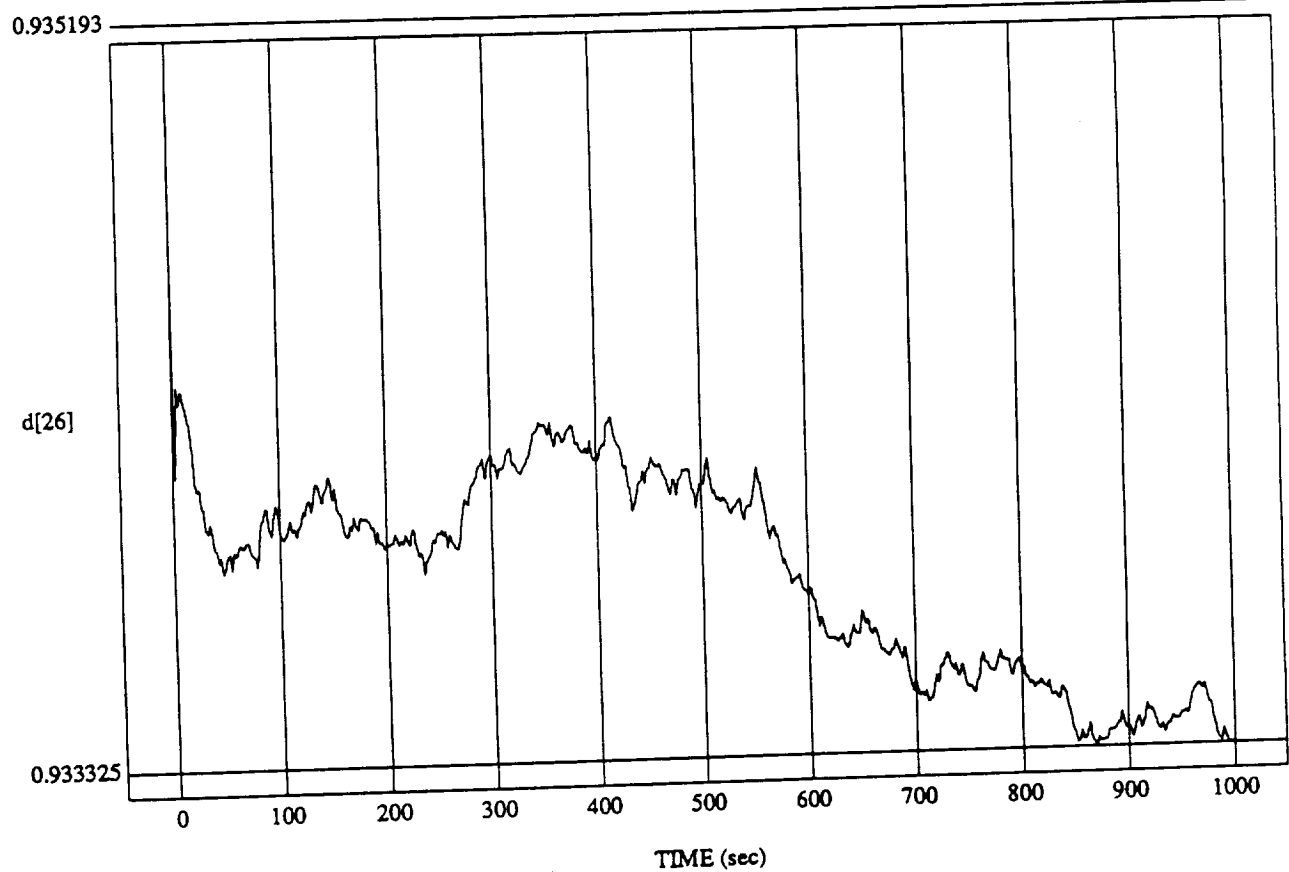
d[25] vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

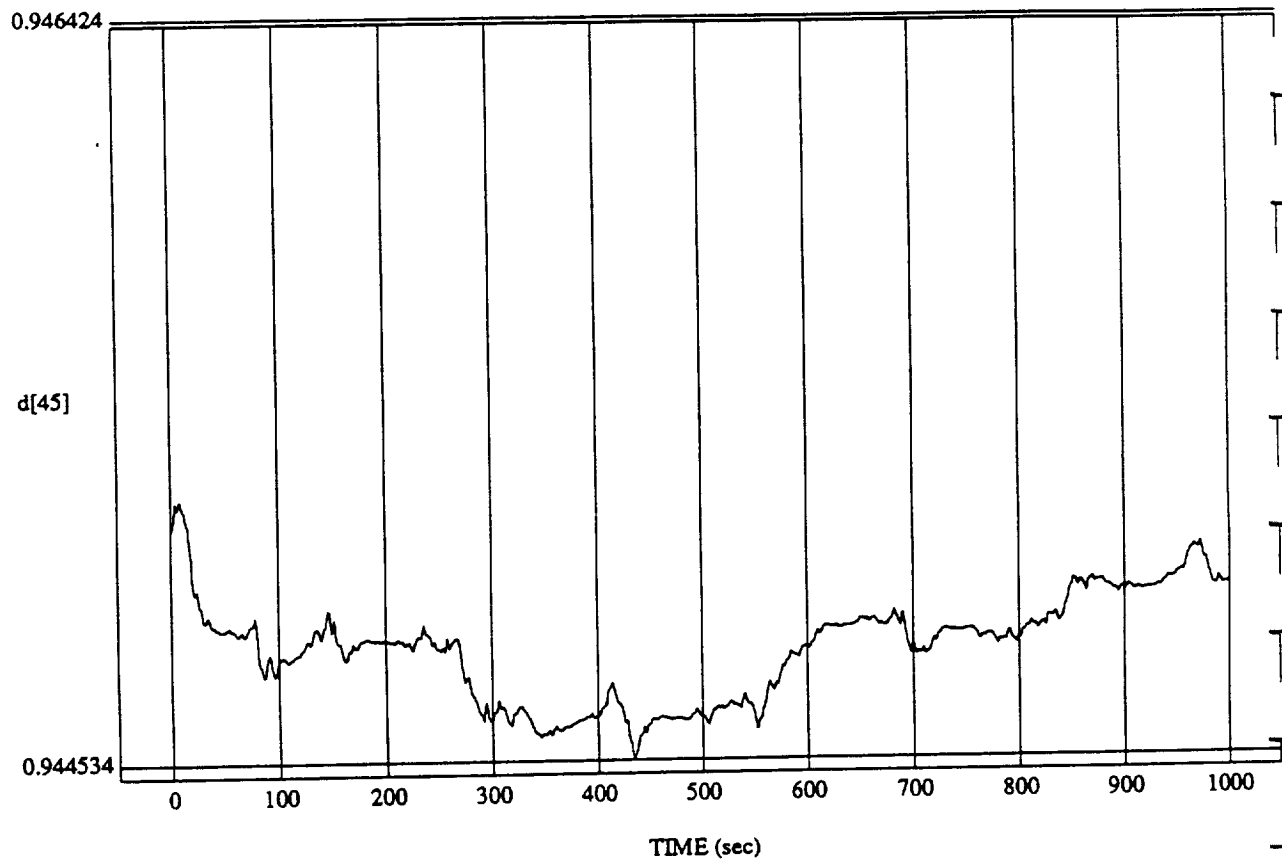
d[26] vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

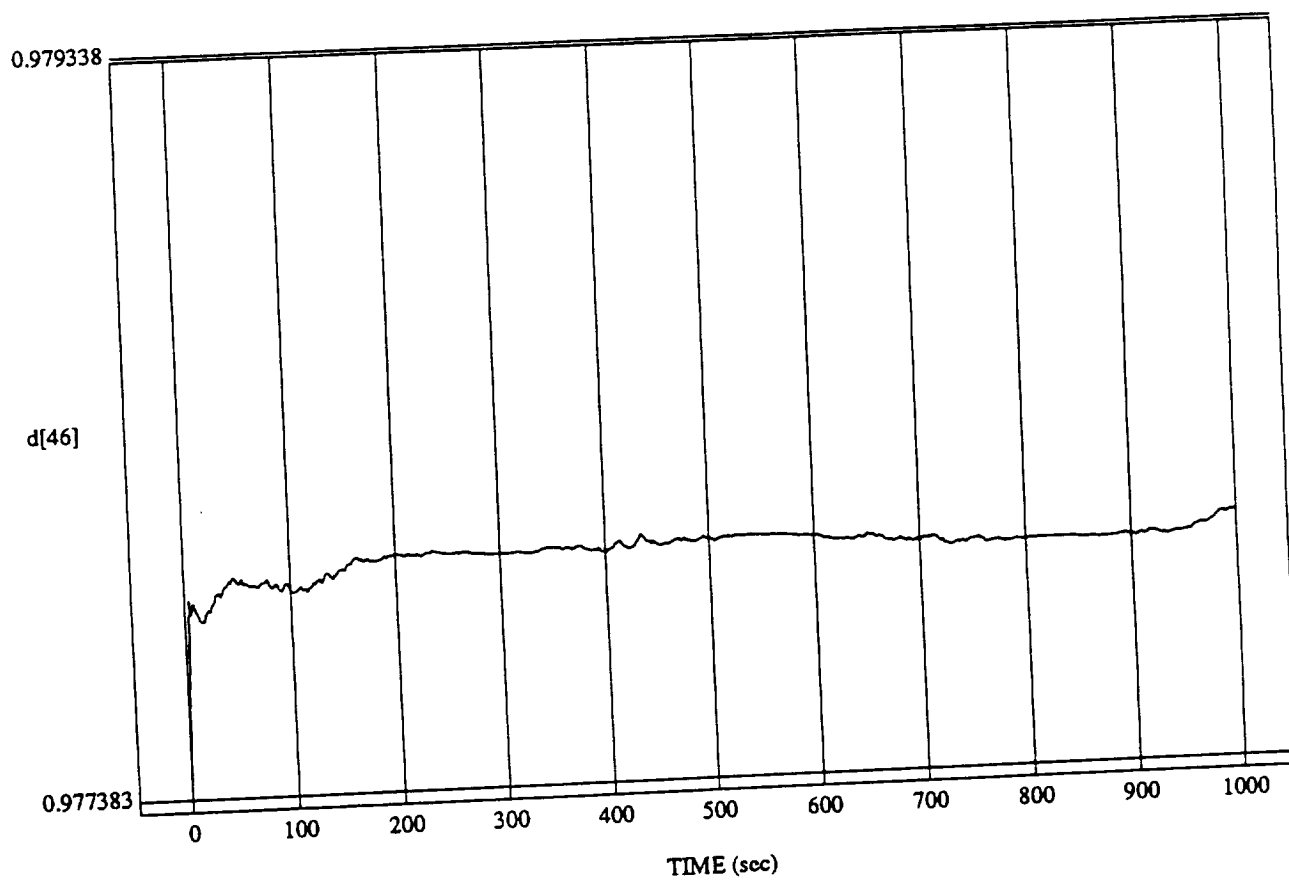
d[45] vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[46] vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992

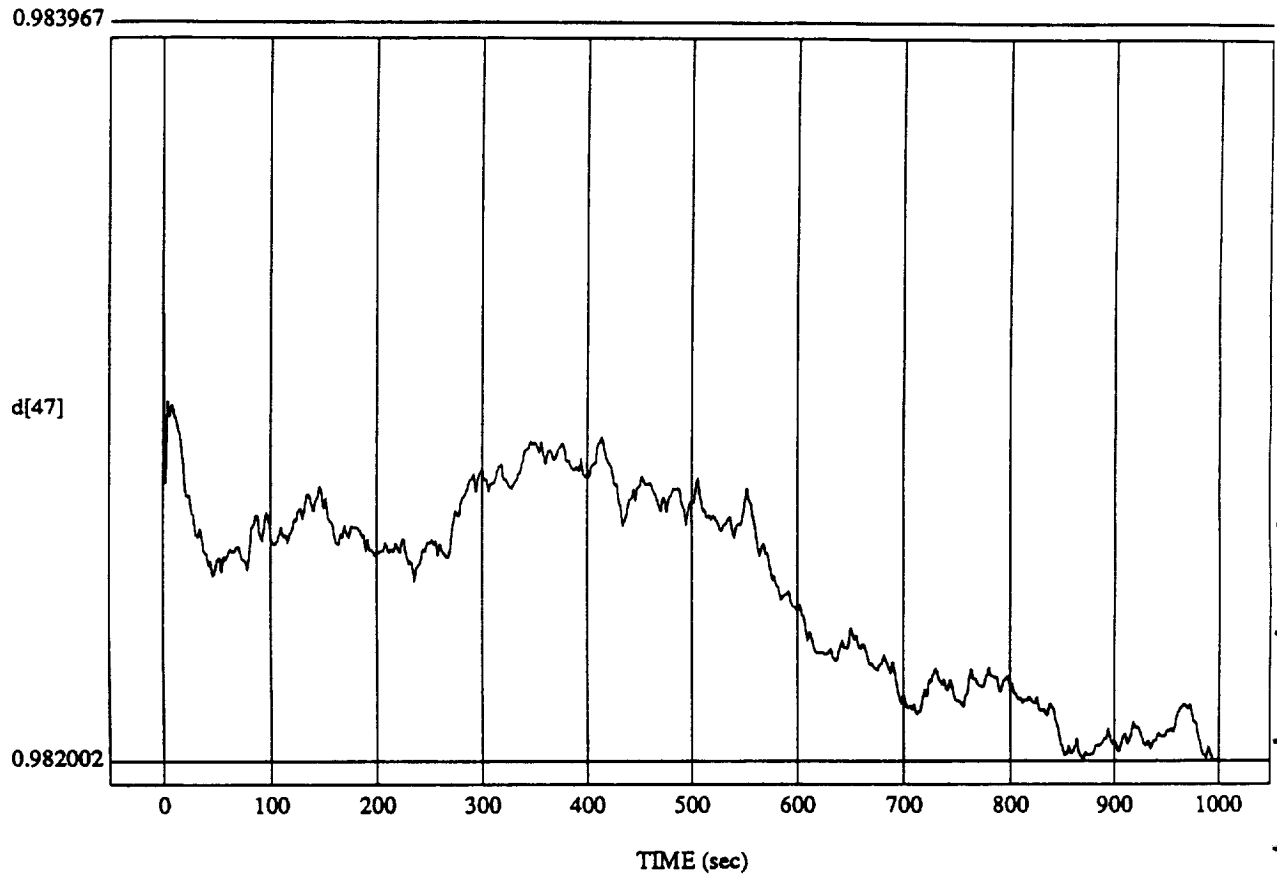


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[47] vs TIME

RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992

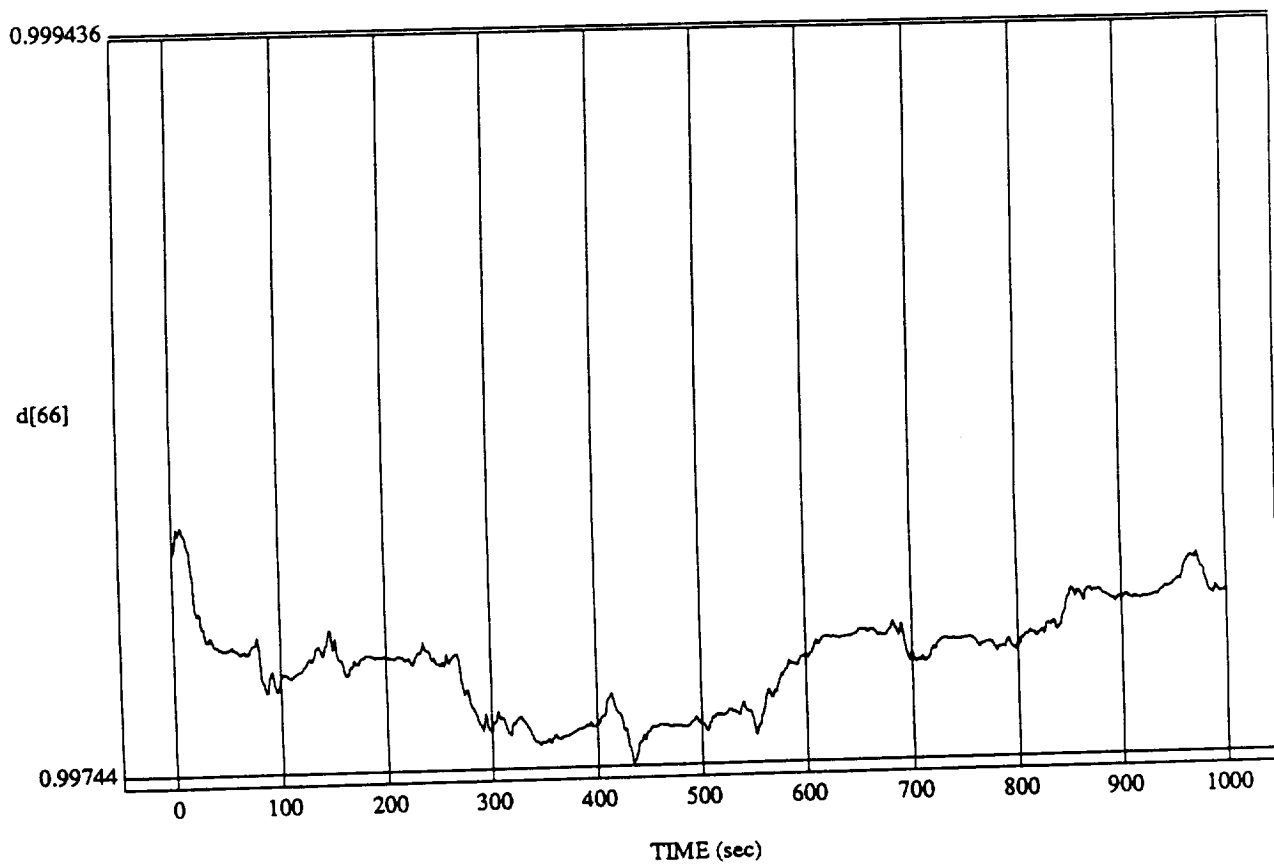


MODULE: ORB\_FUZZ\_BATCH.Jeam2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[66] vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992

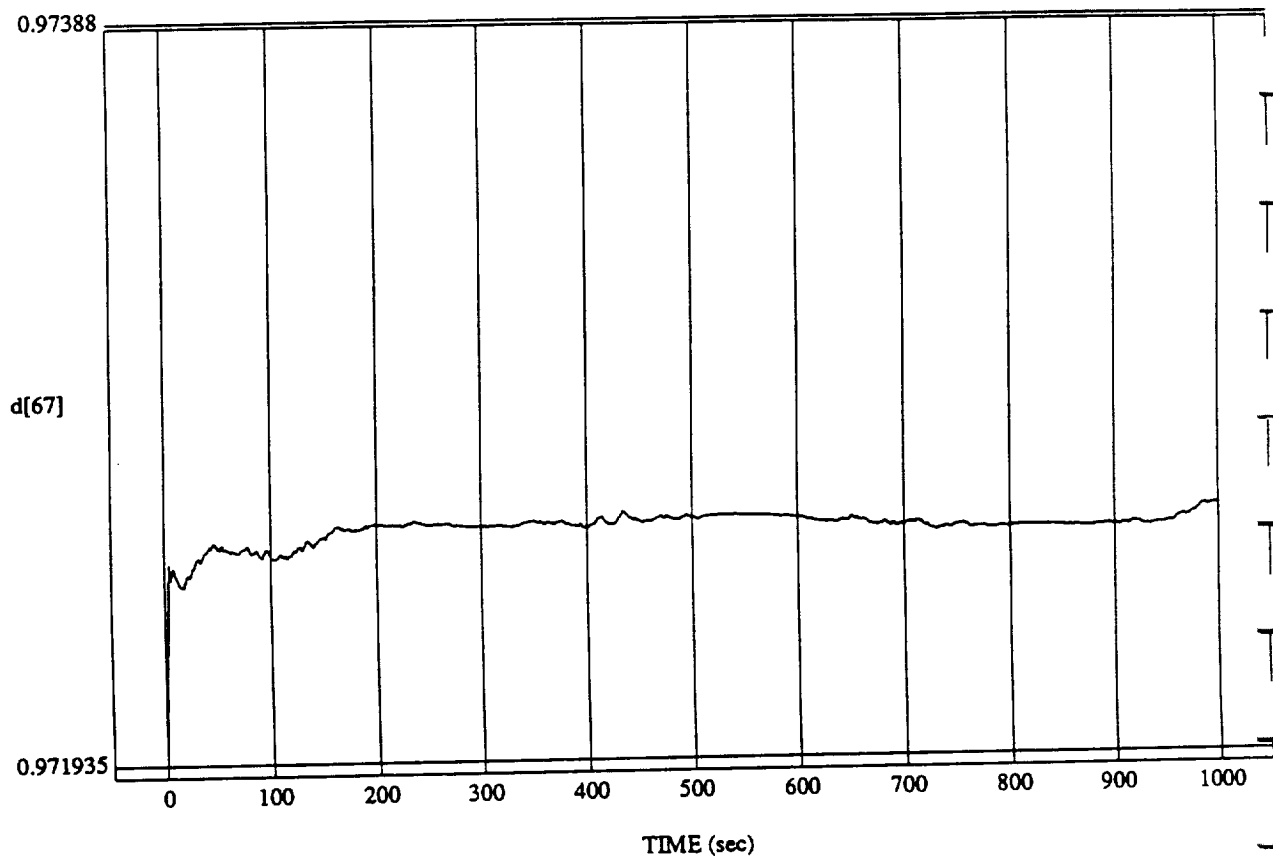


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[67] vs TIME

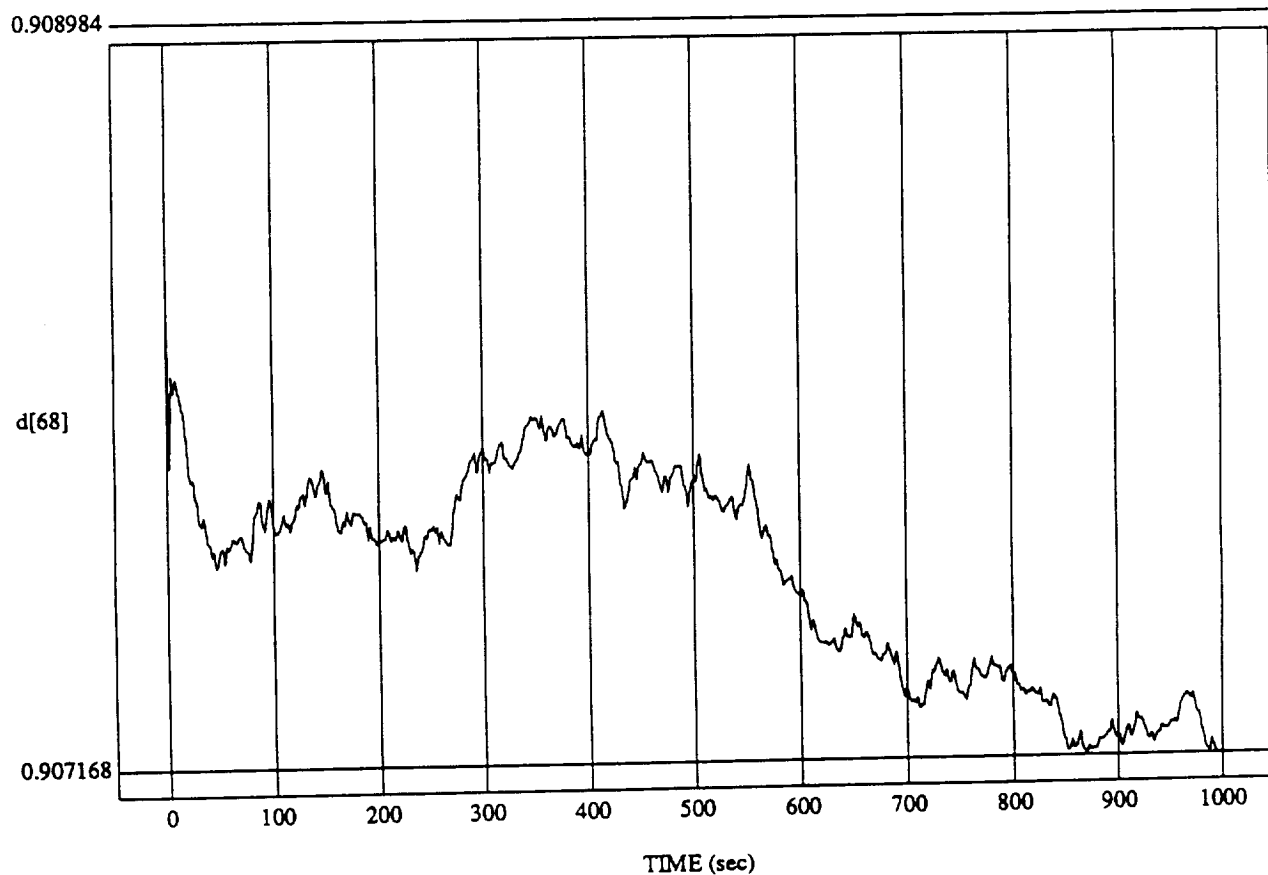
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

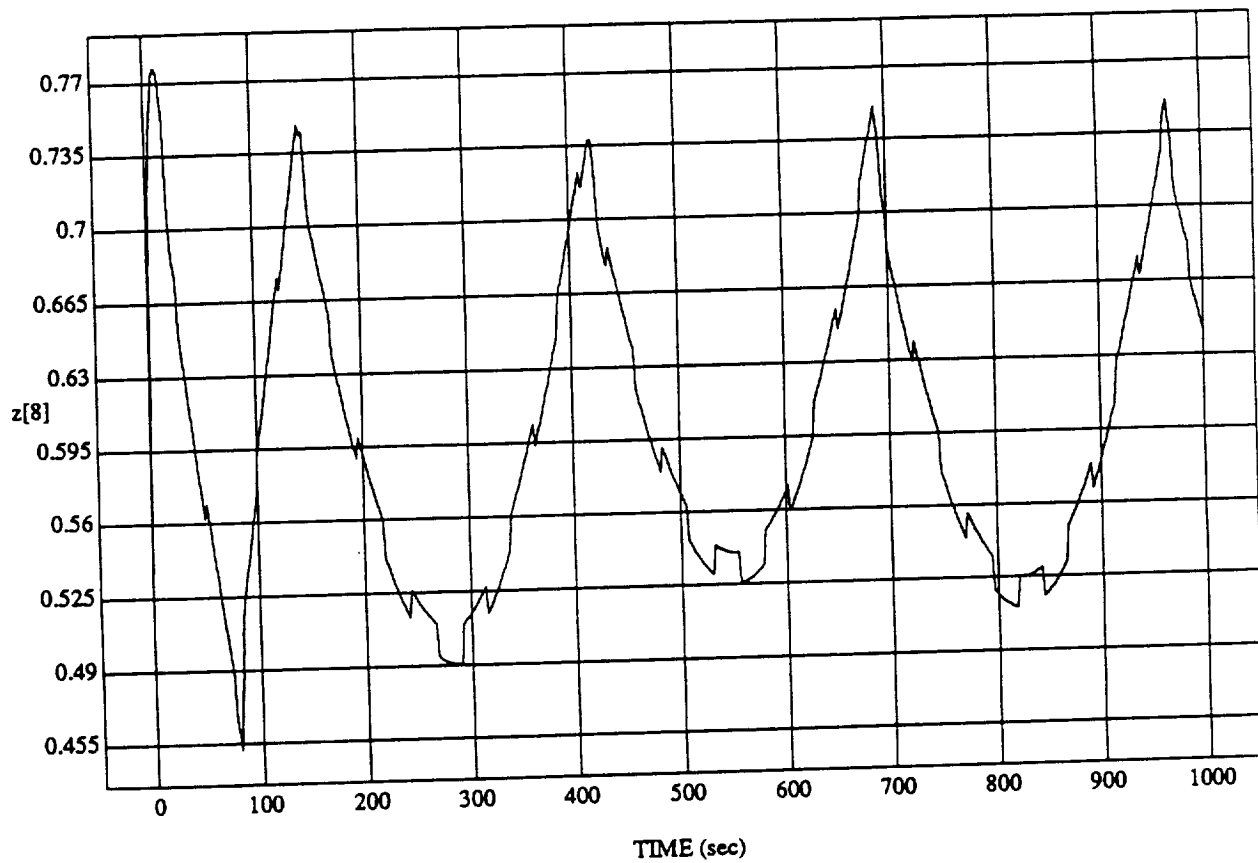
d[68] vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

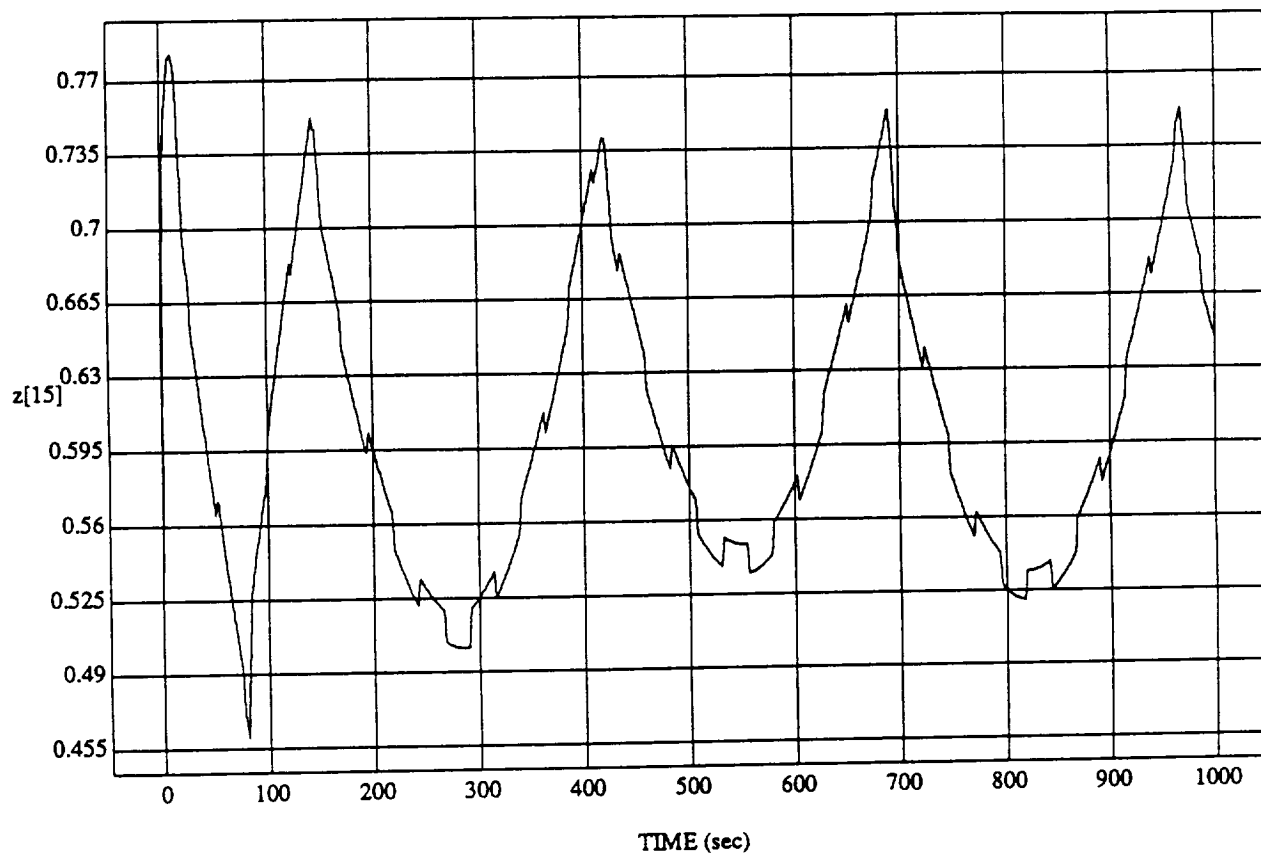
$z[8]$  vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

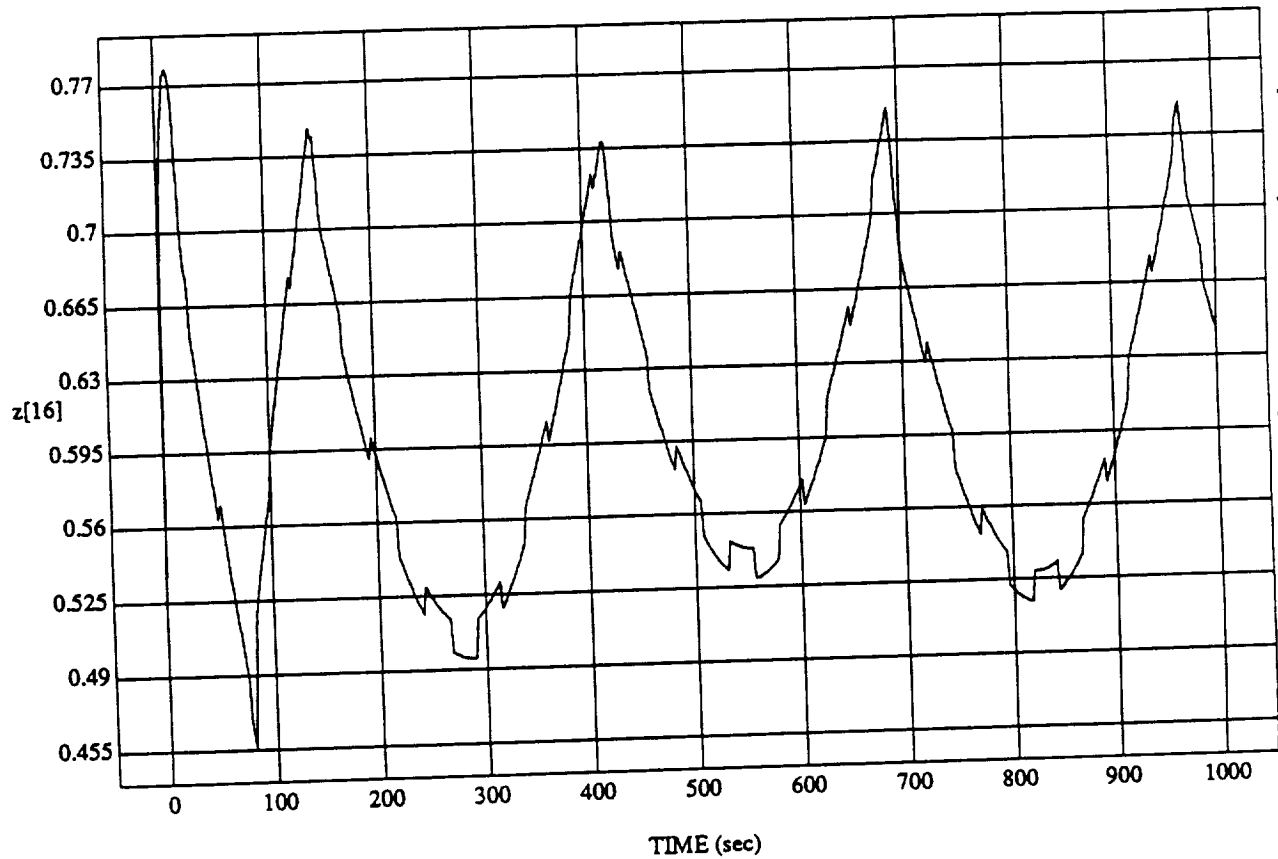
$z[15]$  vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

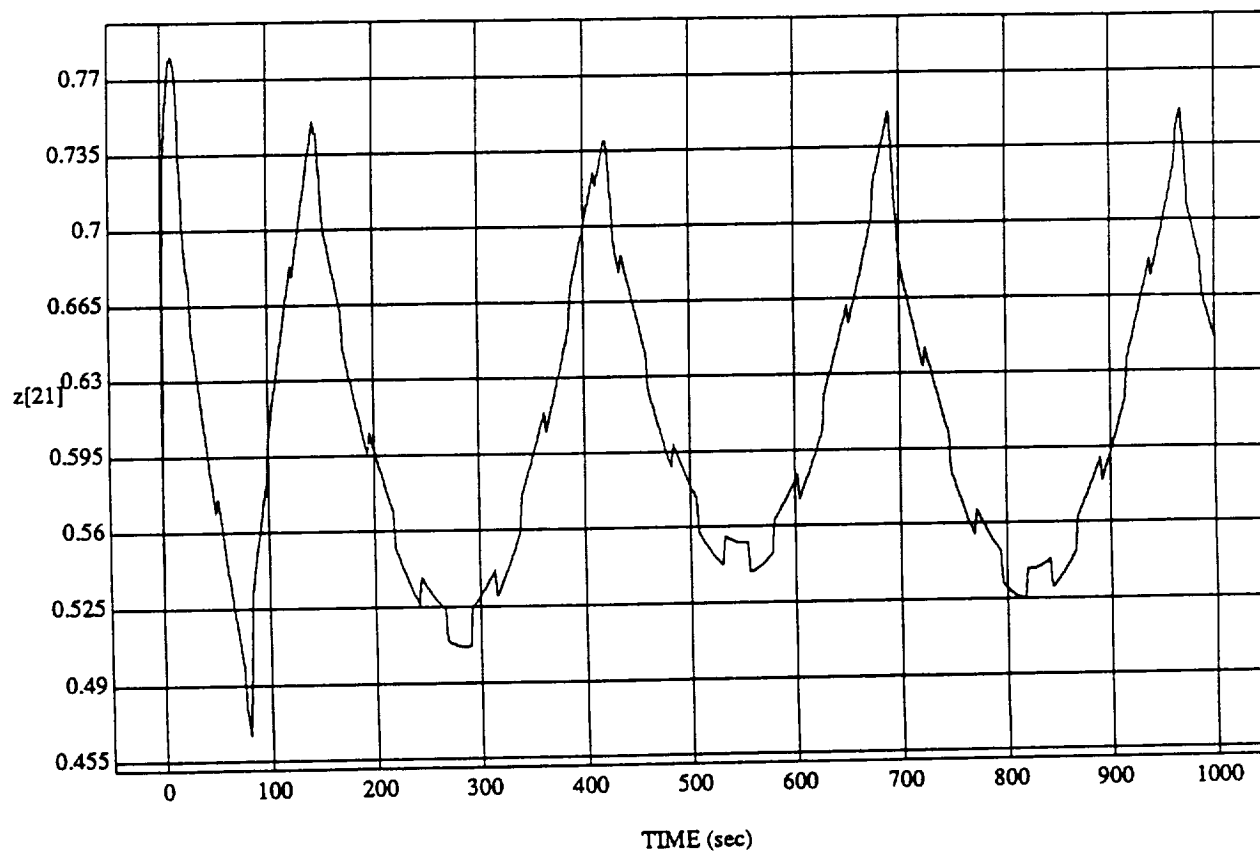
$z[16]$  vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

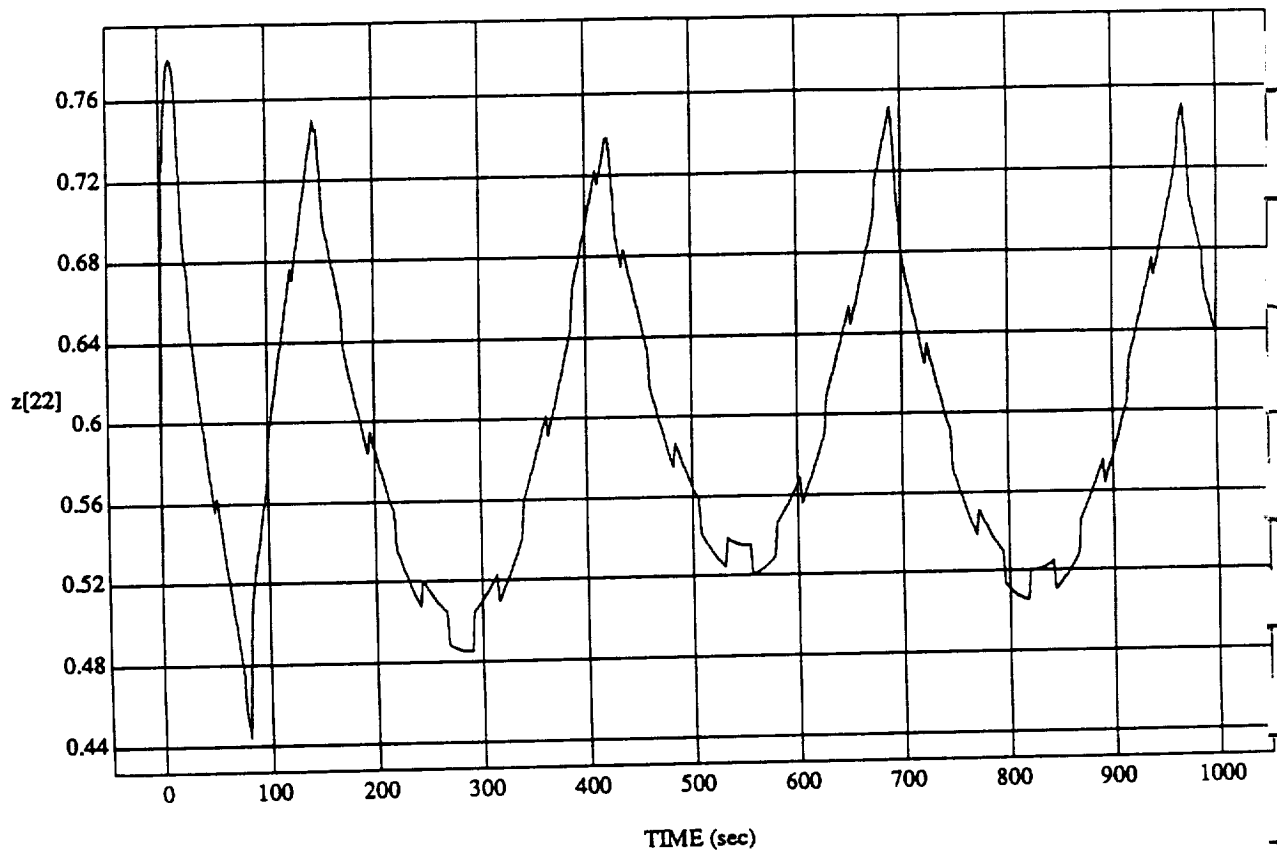
$z[21]$  vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

z[22] vs TIME  
RUN: Fuzzy Learner - Normalized By Rules (Only) - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



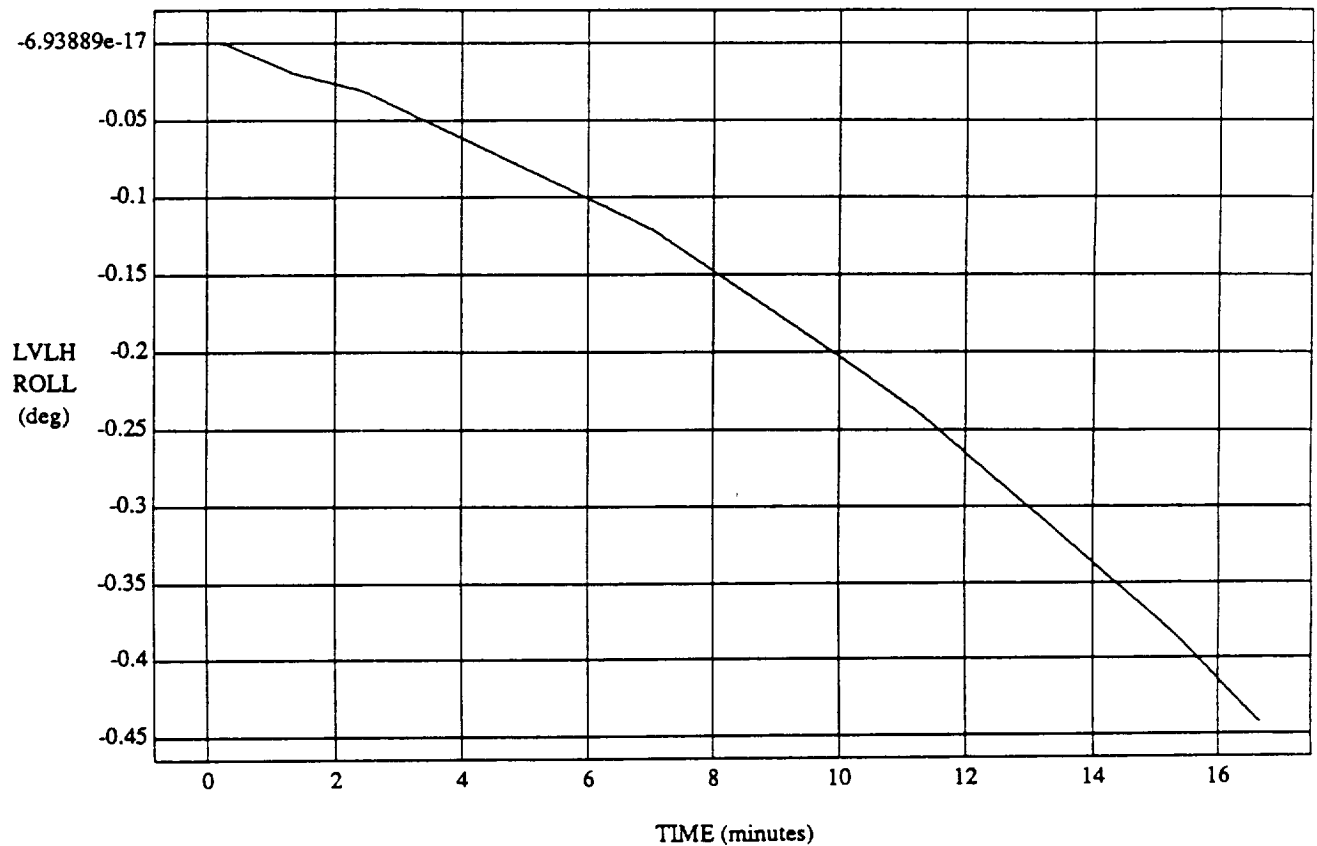




X

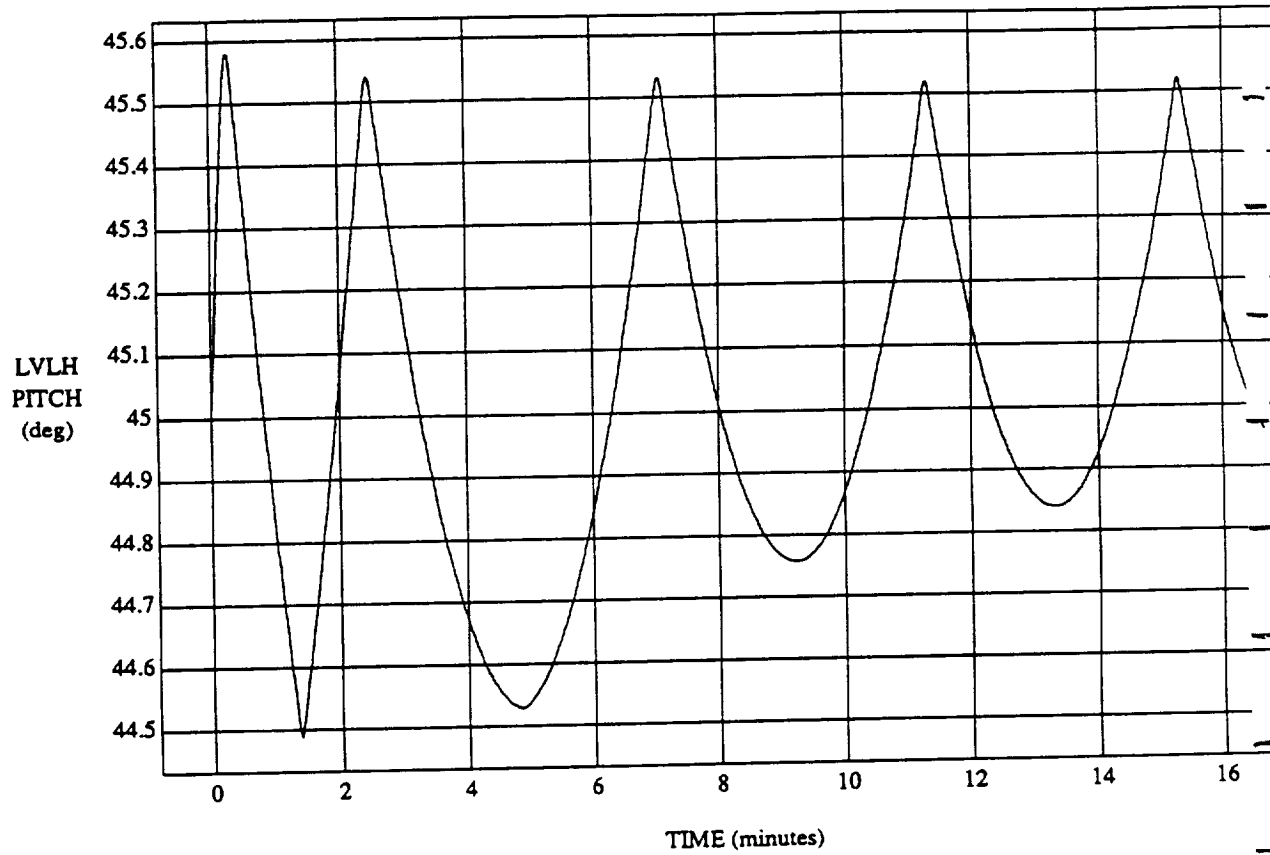
SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

**LVLH EULER PYR ROLL vs TIME**  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

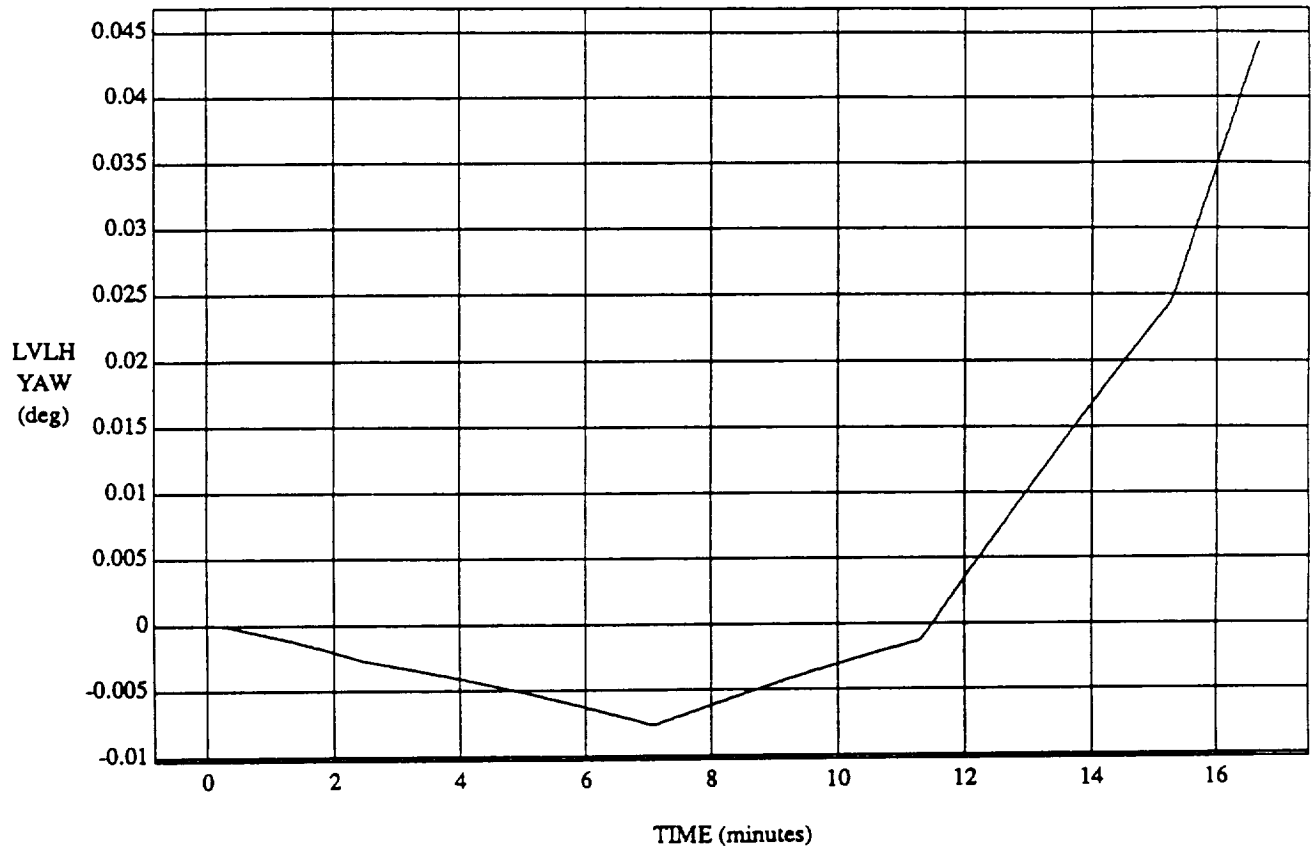
LVLH EULER PYR PITCH vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

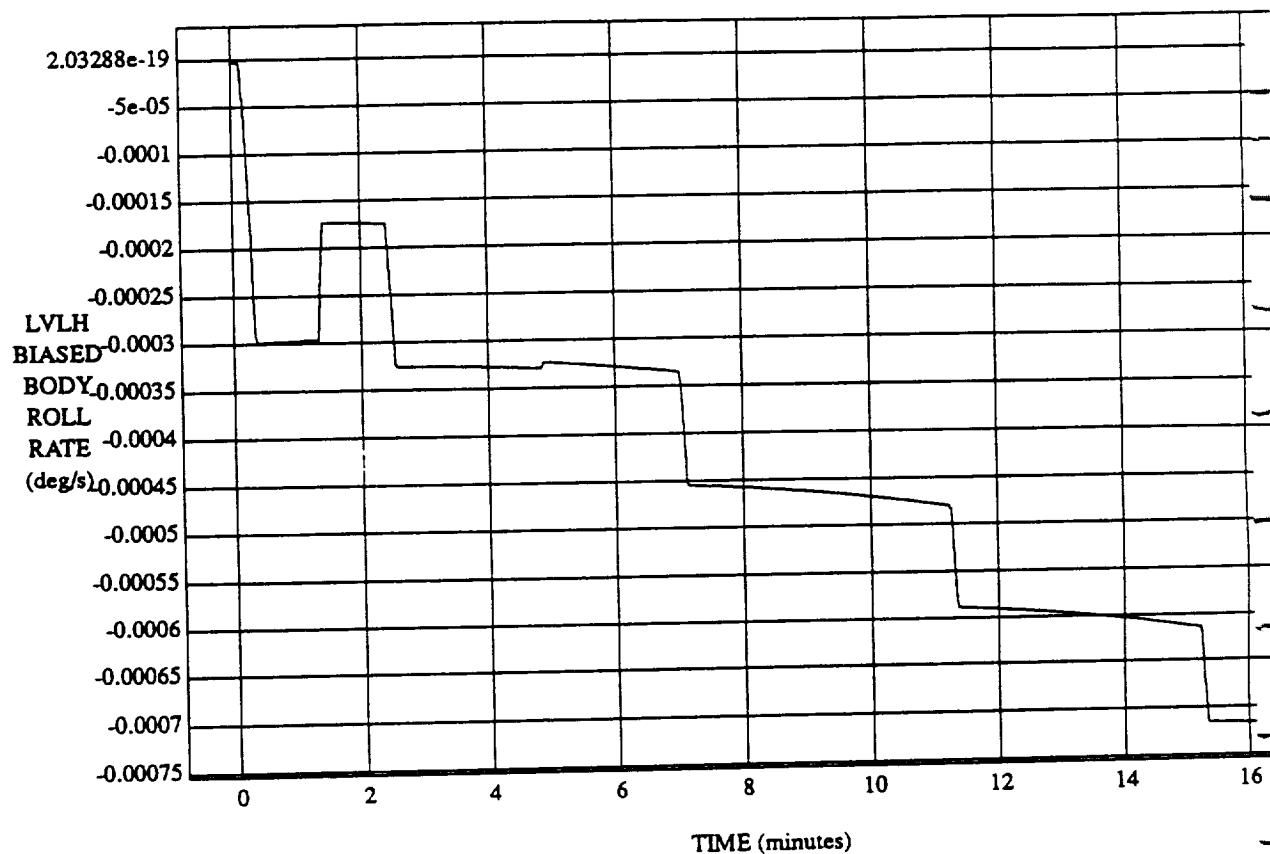
**LVLH EULER PYR YAW vs TIME**  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

# LVLH BIASED BODY ROLL RATE vs TIME

RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992

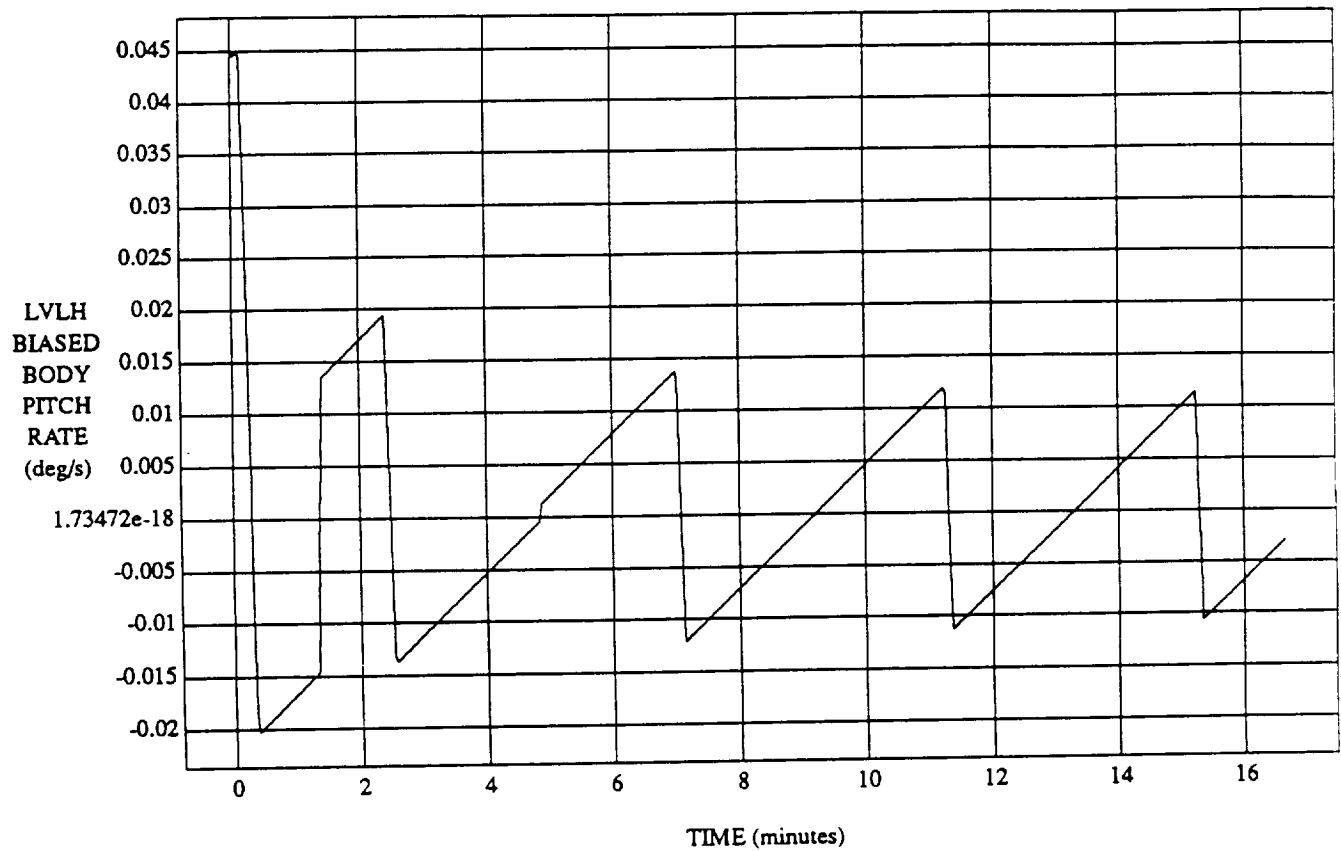


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH BIASED BODY PITCH RATE vs TIME

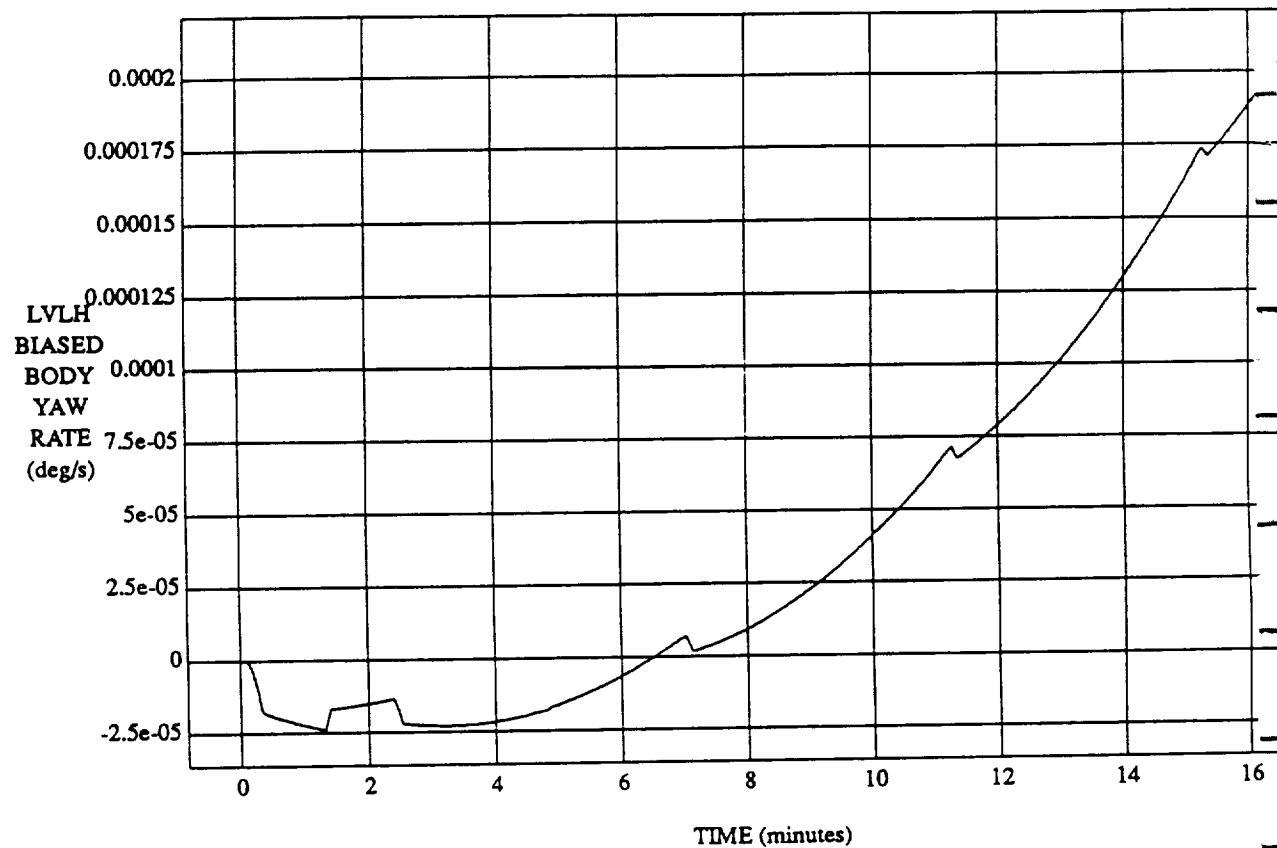
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

# LVLH BIASED BODY YAW RATE vs TIME

RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992

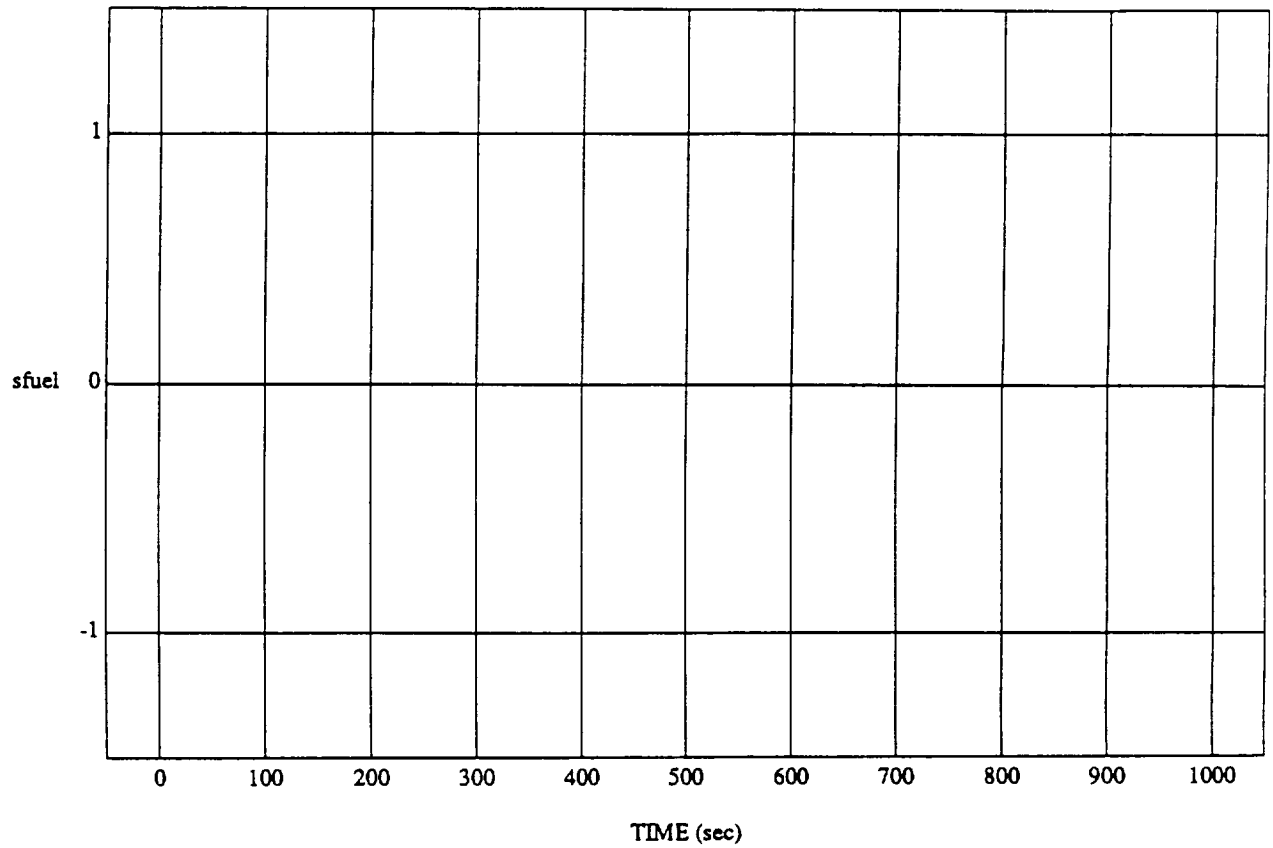


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

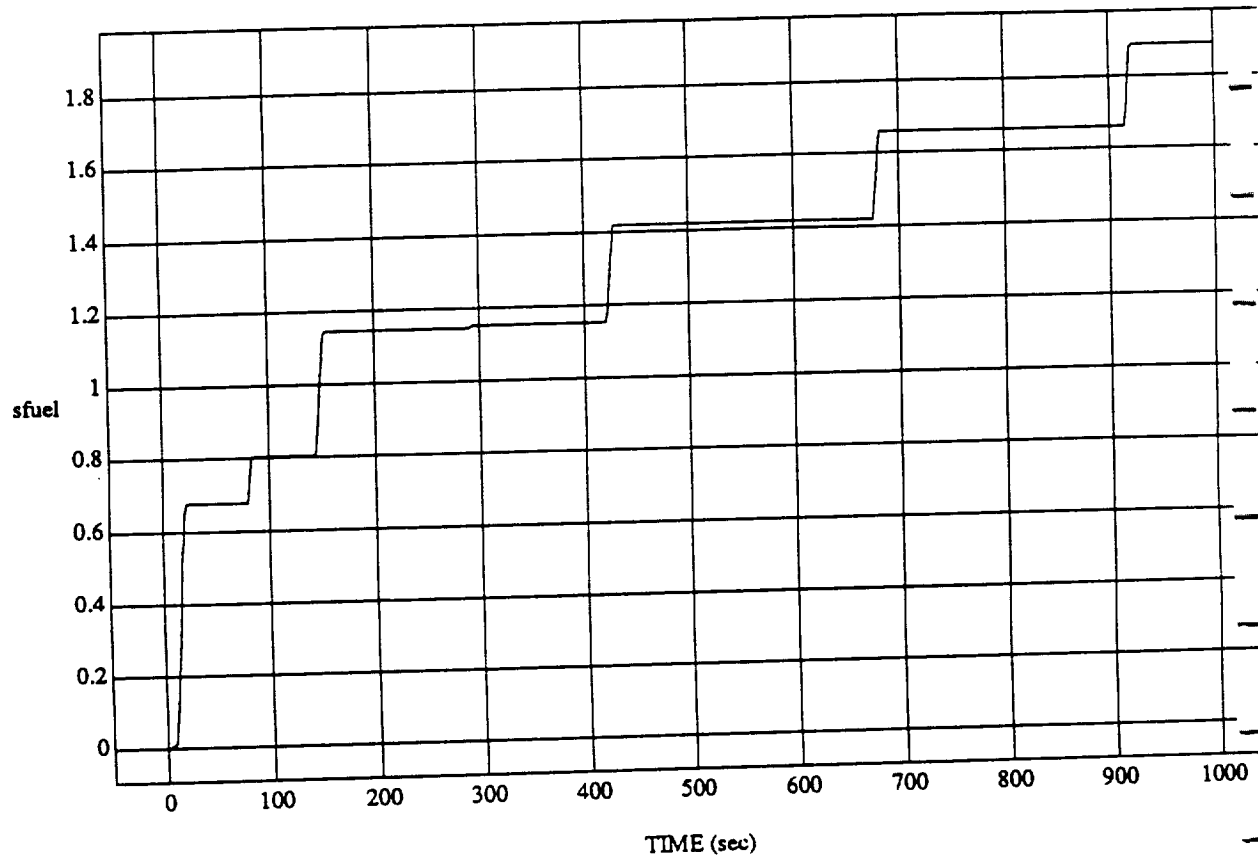
sfuel vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.primary  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992

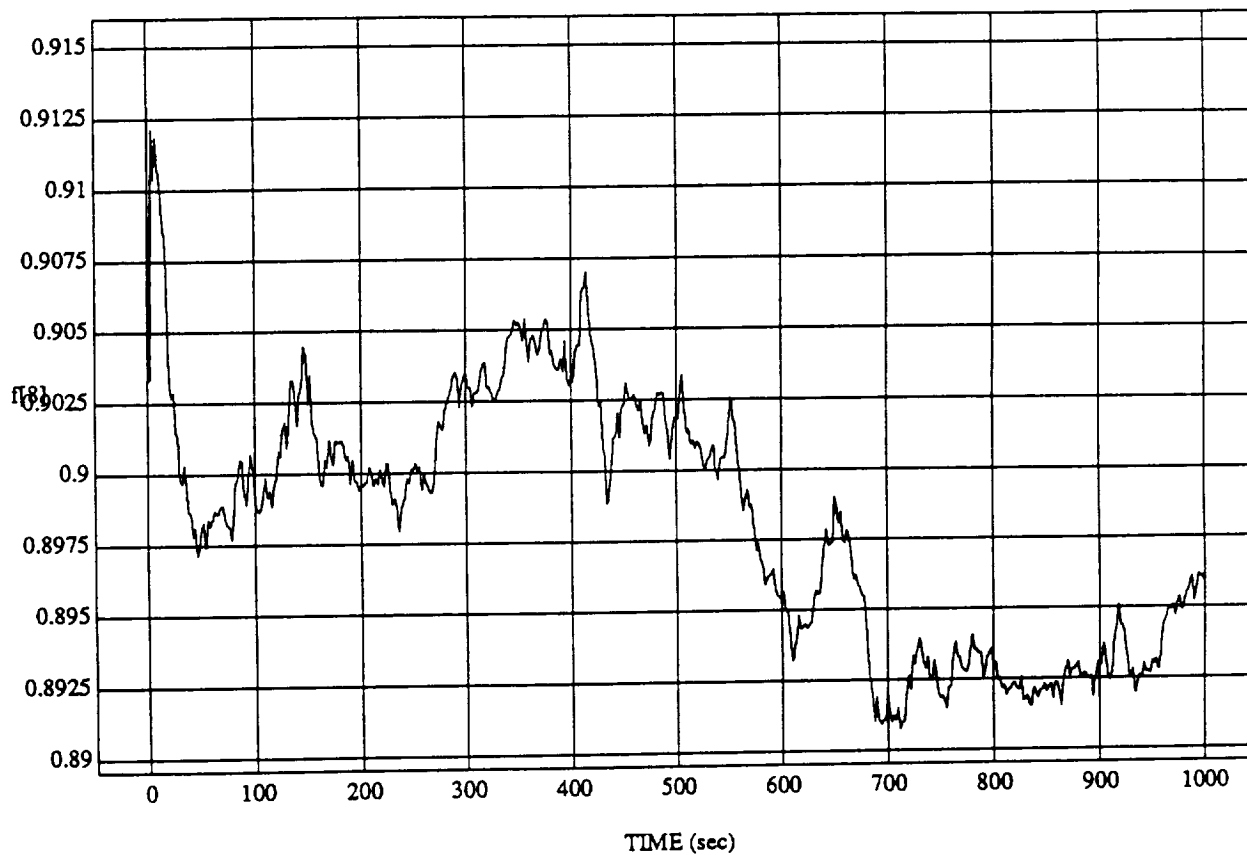


MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[8]$  vs TIME

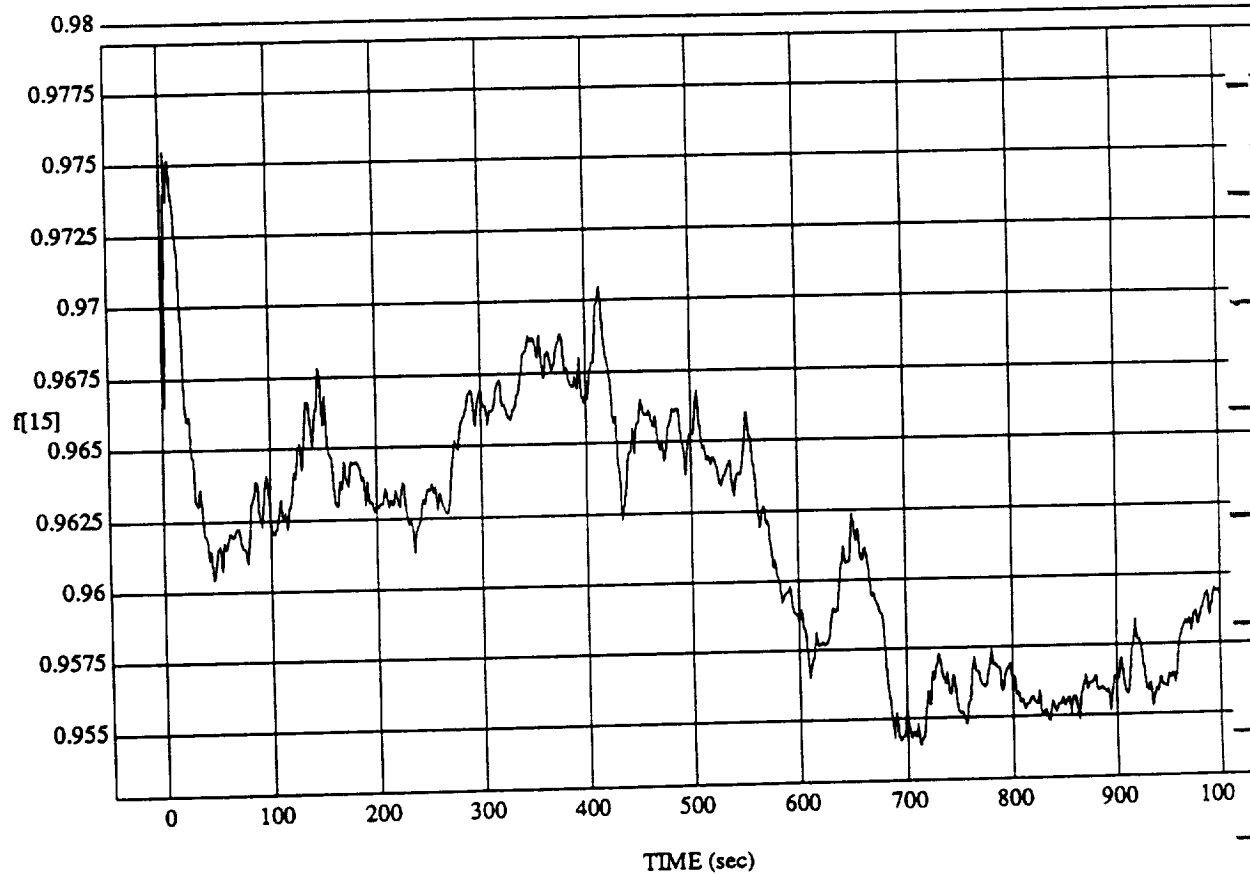
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[15] vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992

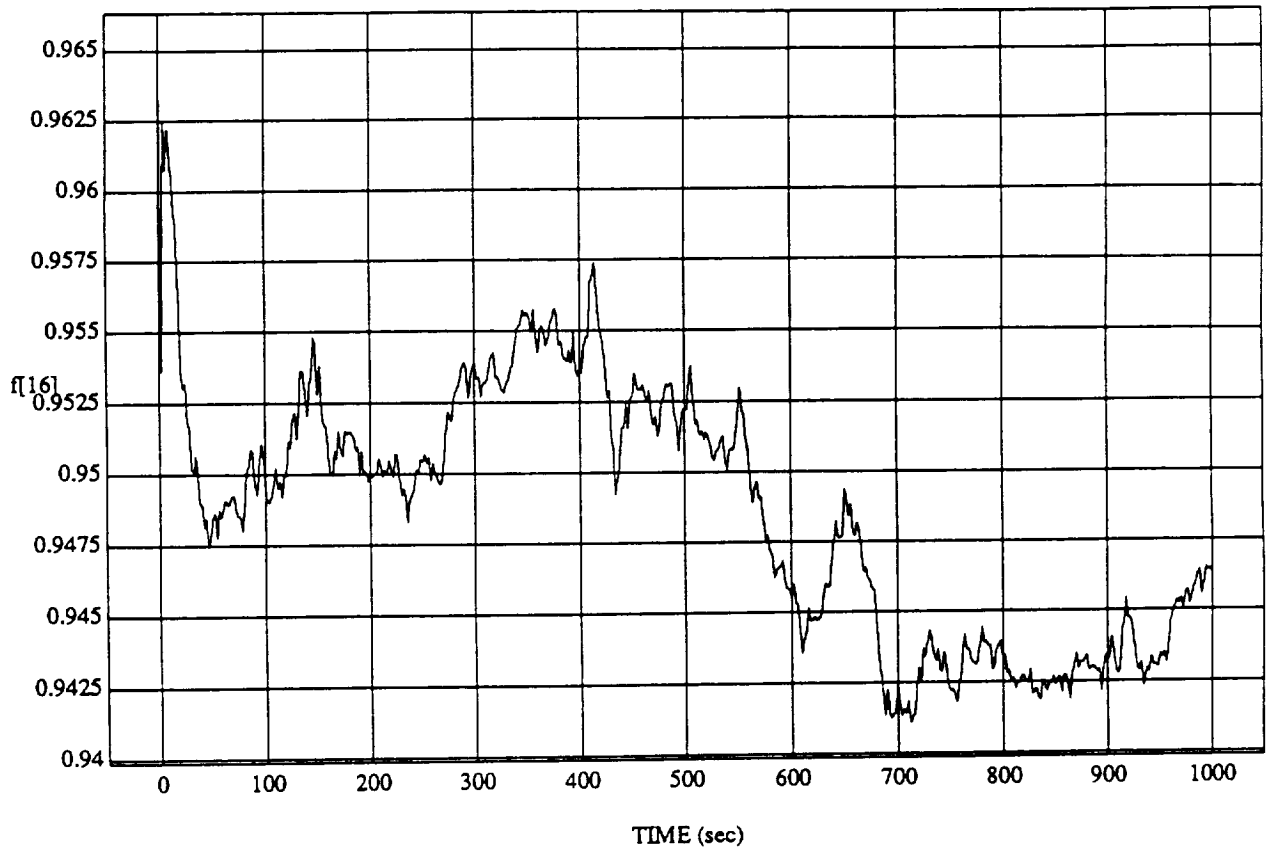


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[16]$  vs TIME

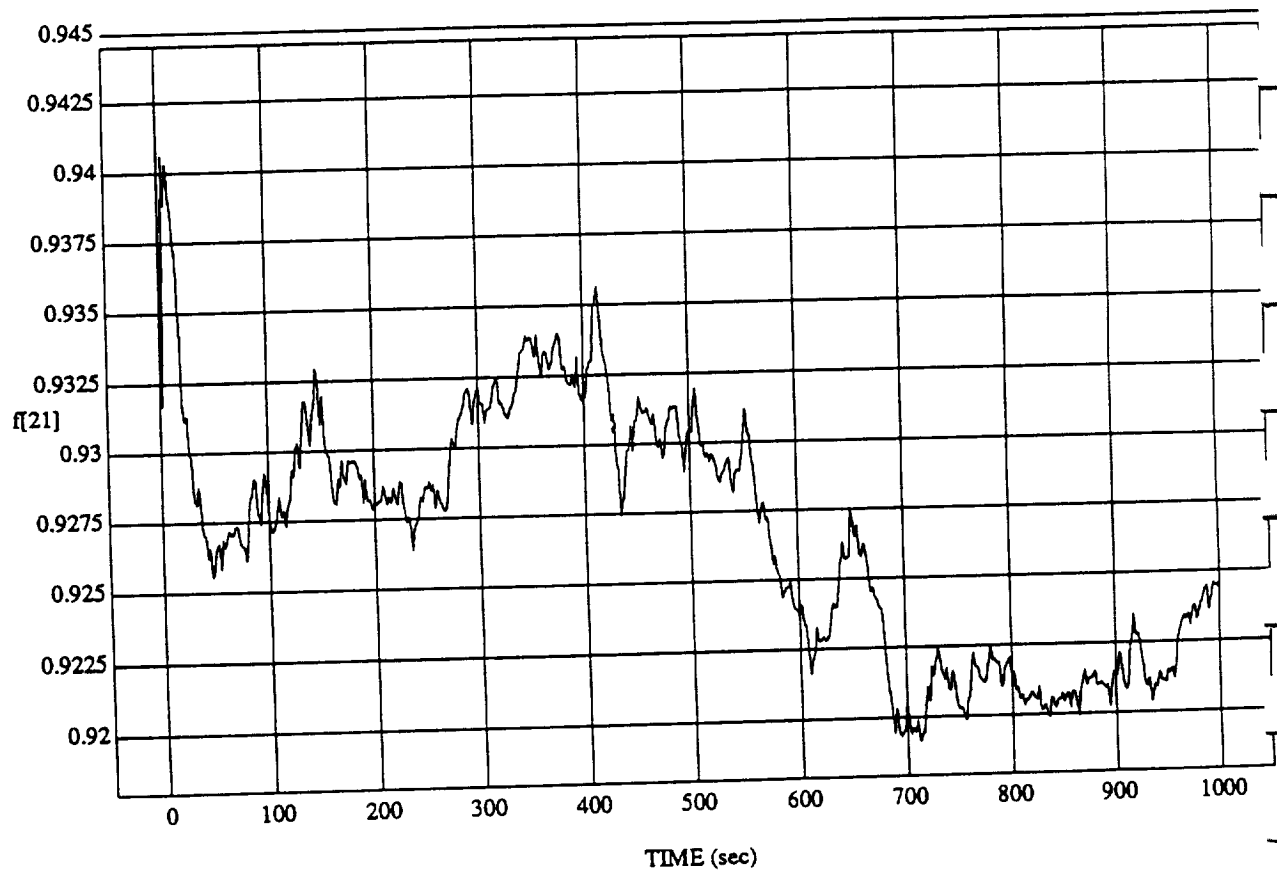
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

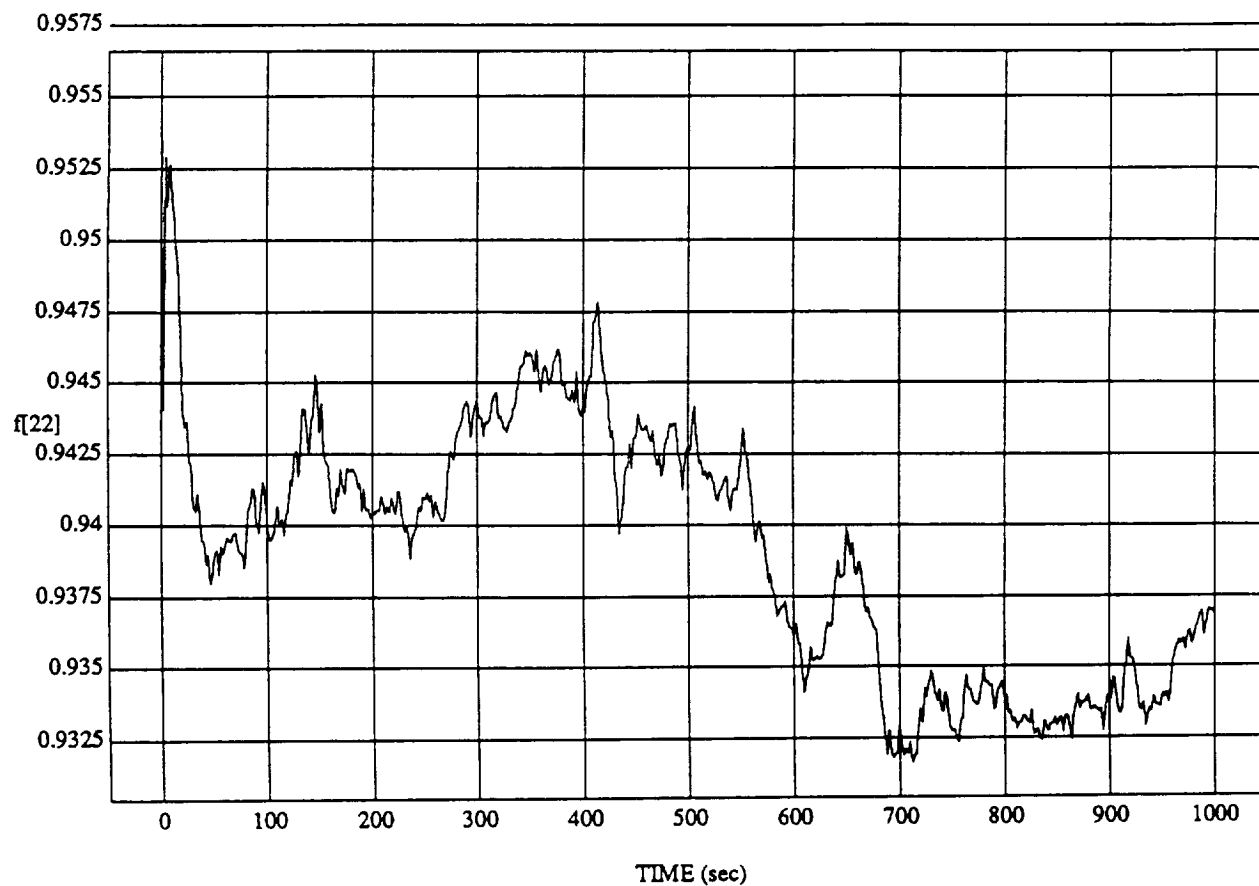
$f[21]$  vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.1cam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

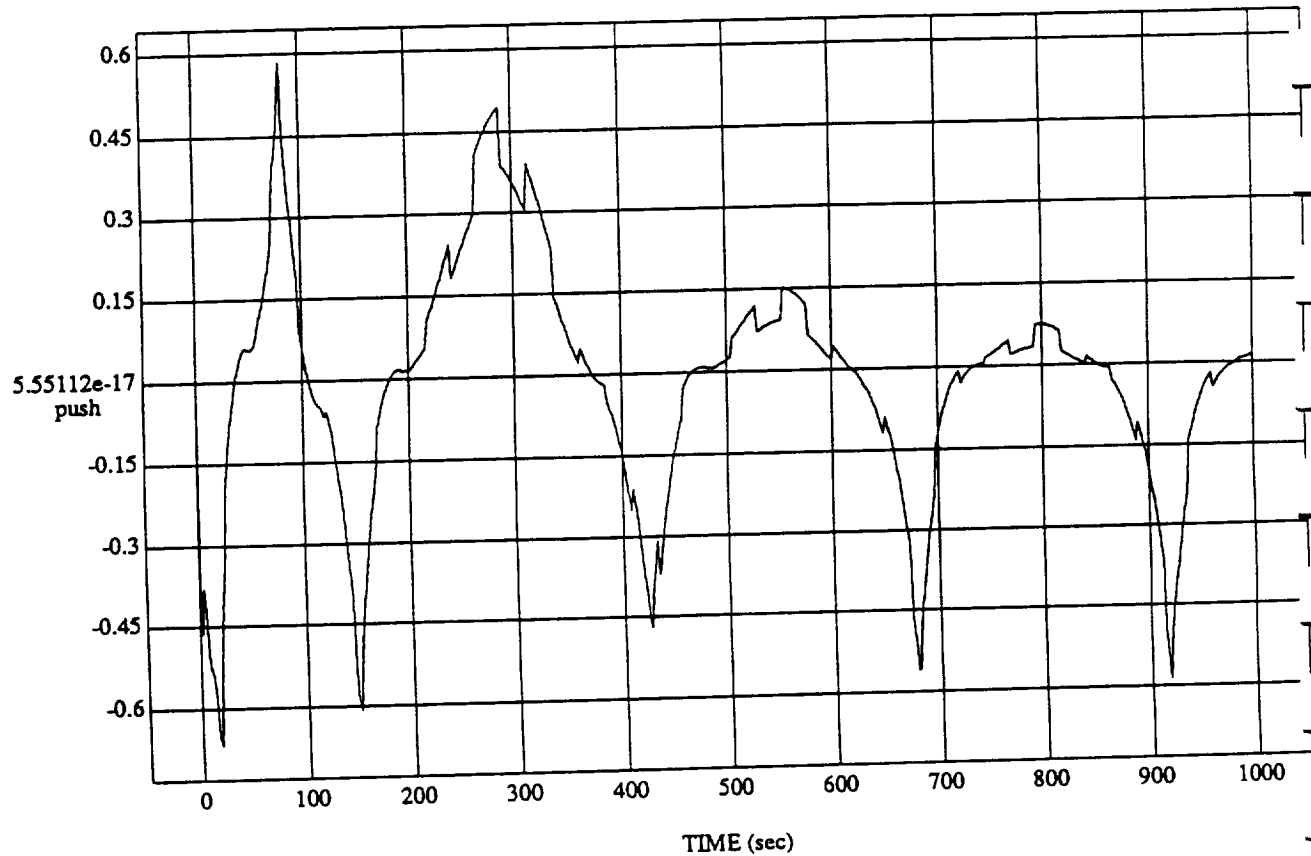
f[22] vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

push vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992

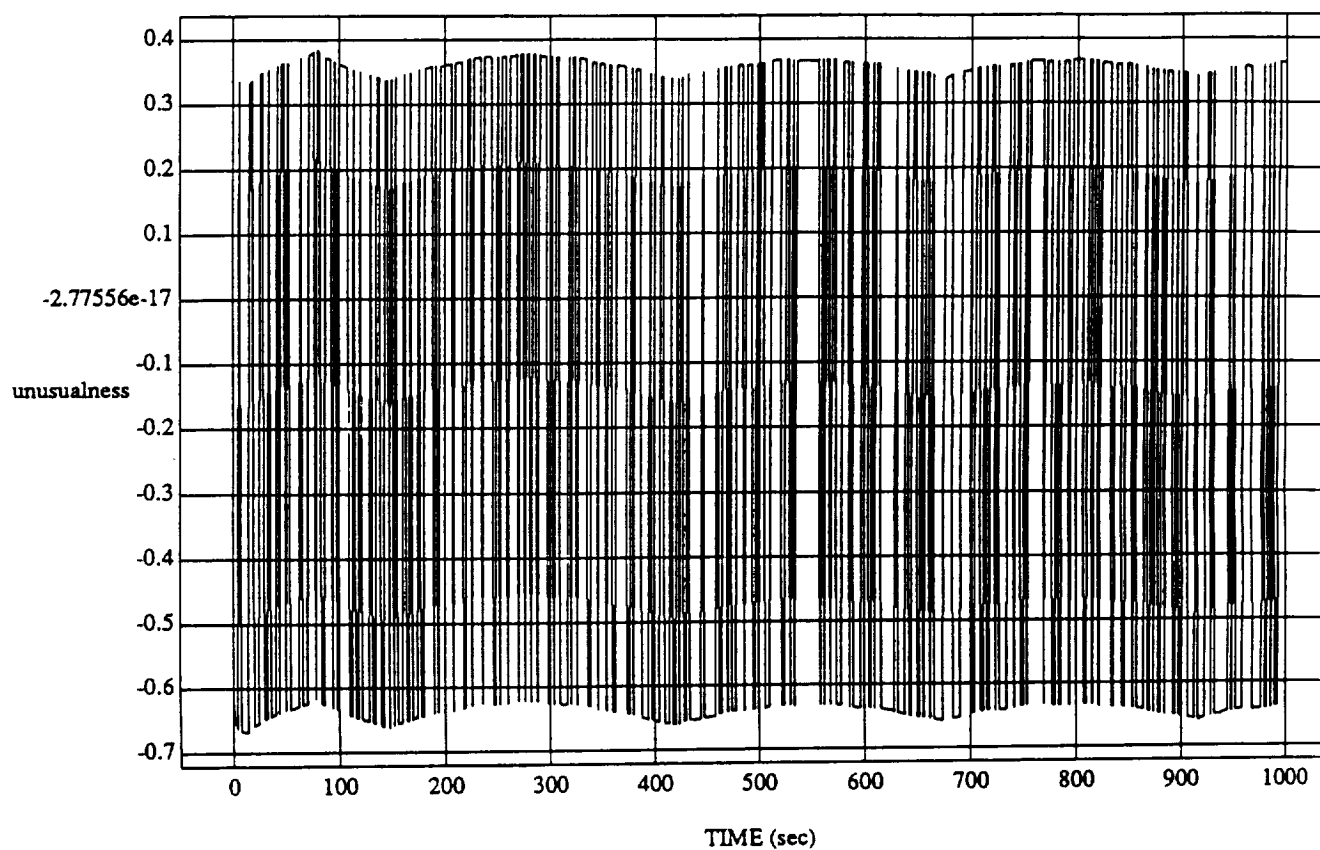


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

unusualness vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992

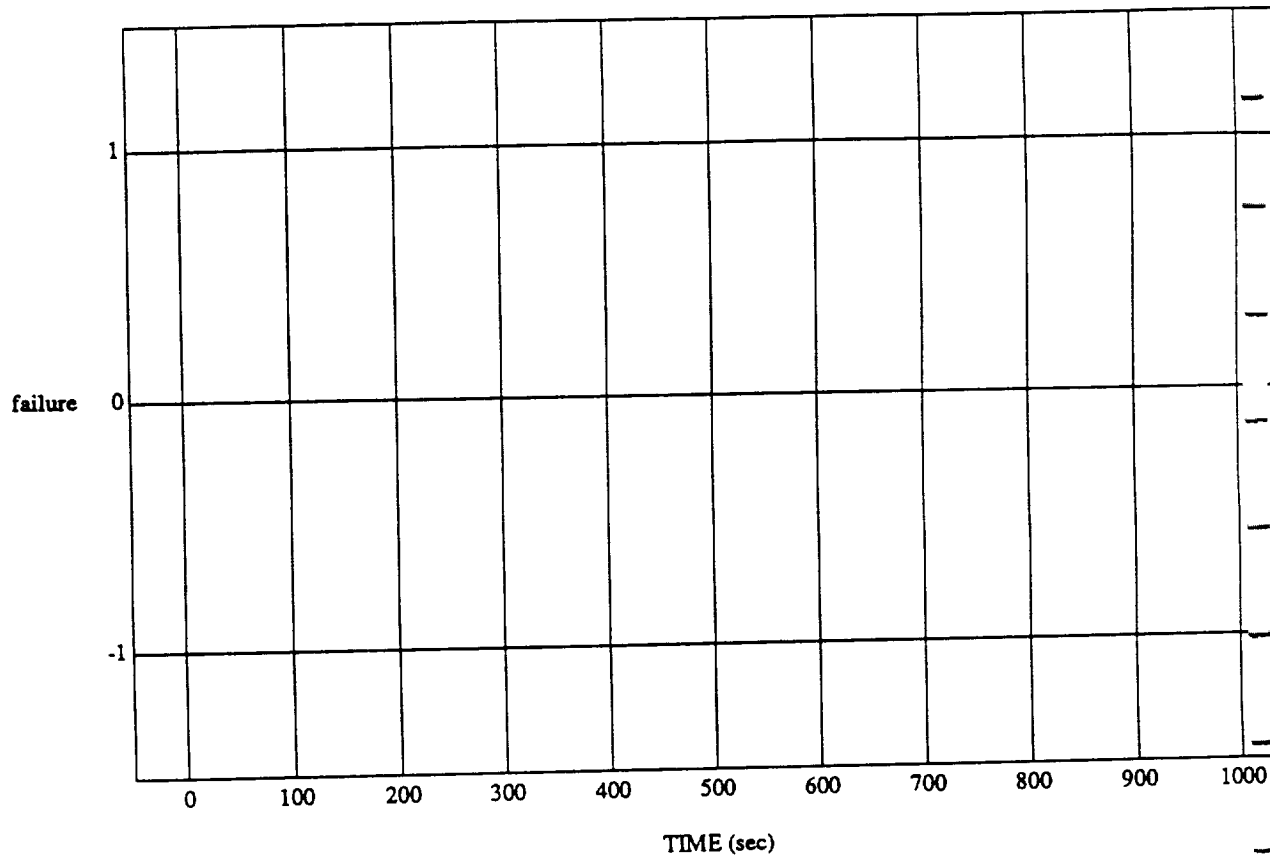


MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

failure vs TIME

RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992

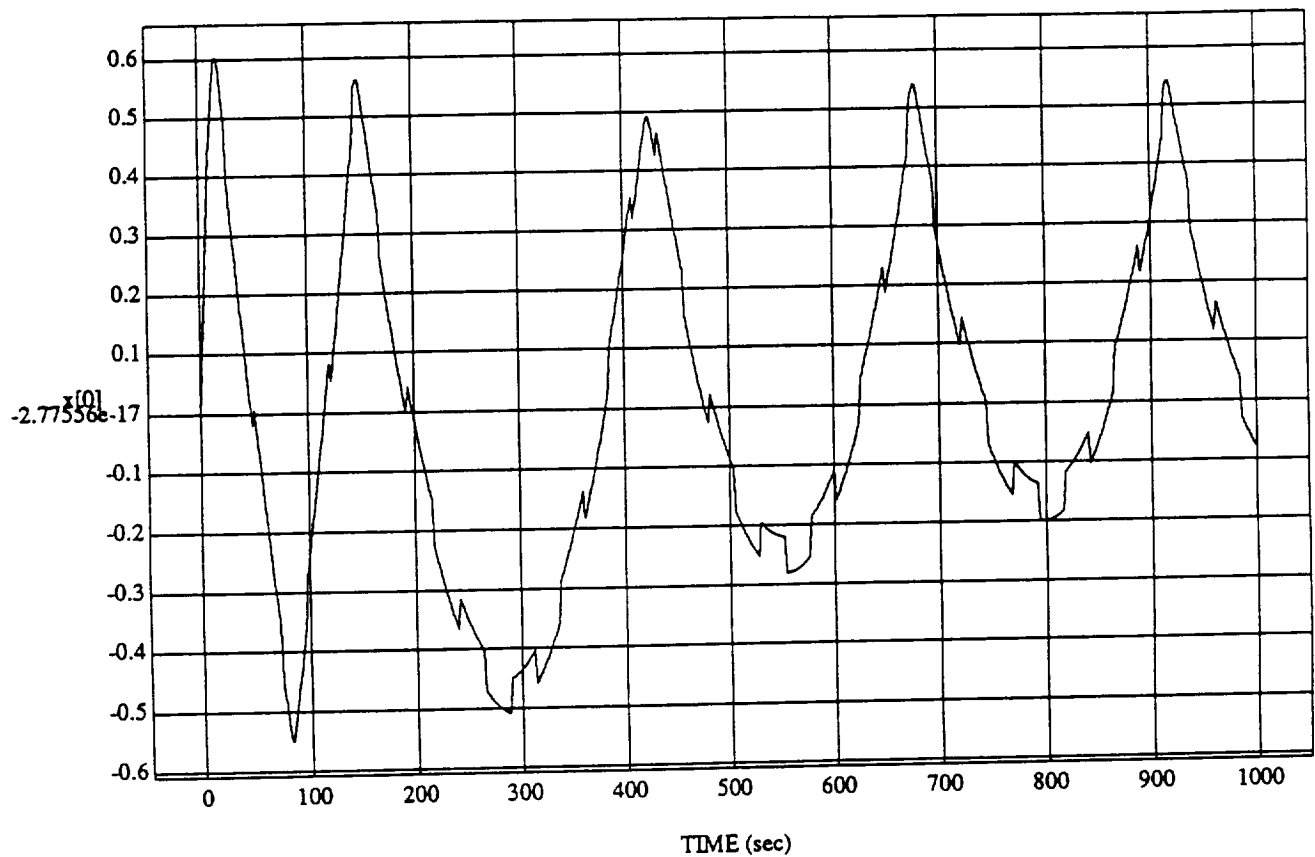


MODULE: ORB\_FUZZ\_BATCH1eam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$x[0]$  vs TIME

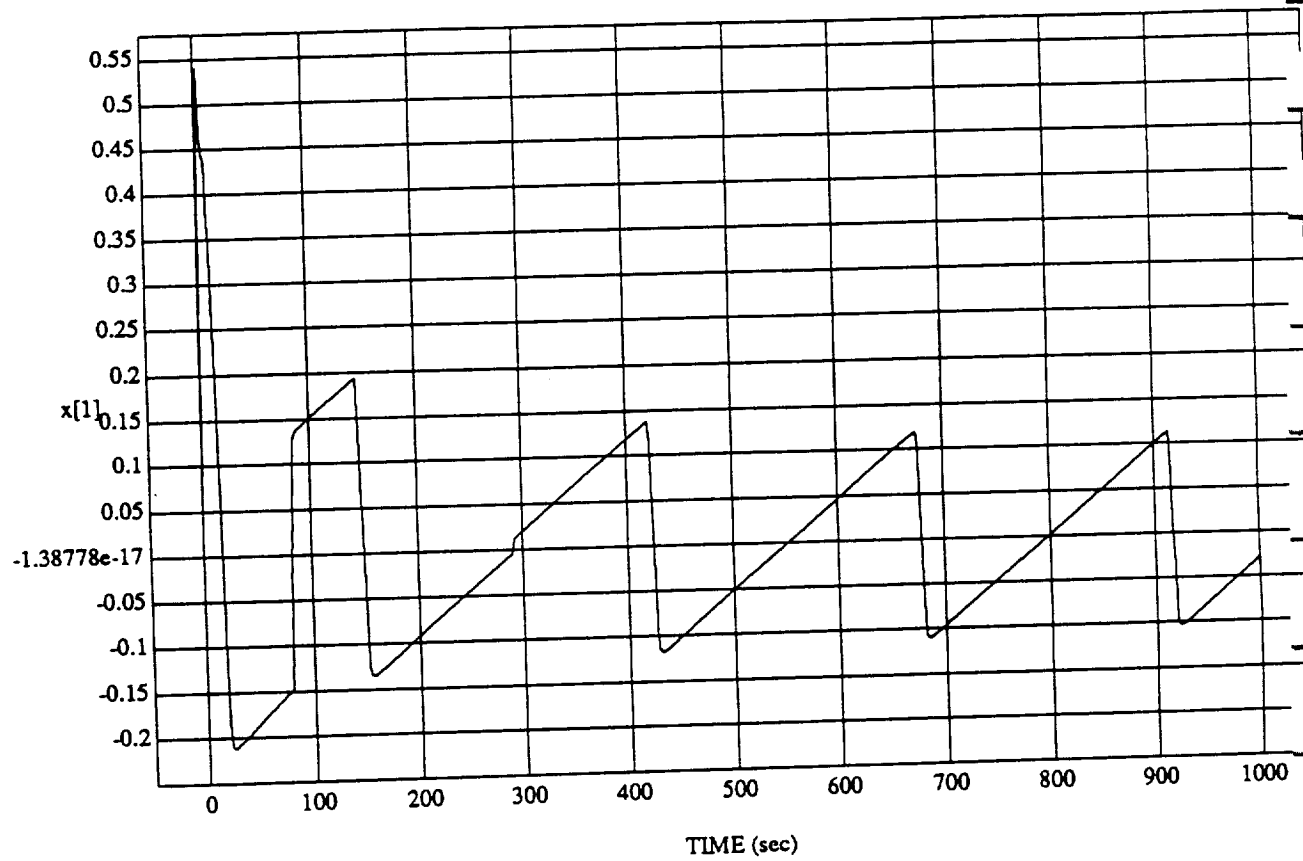
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$x[1]$  vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992

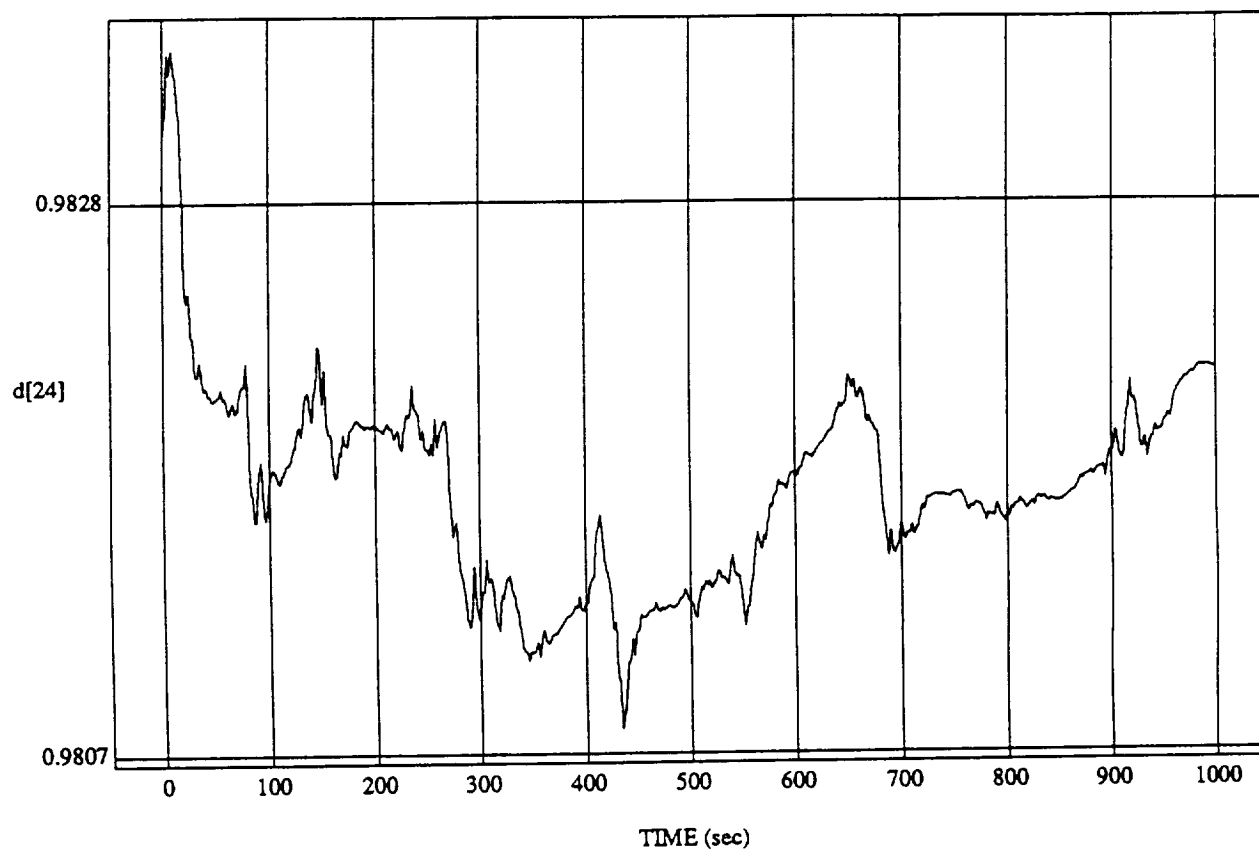


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[24] vs TIME

RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992

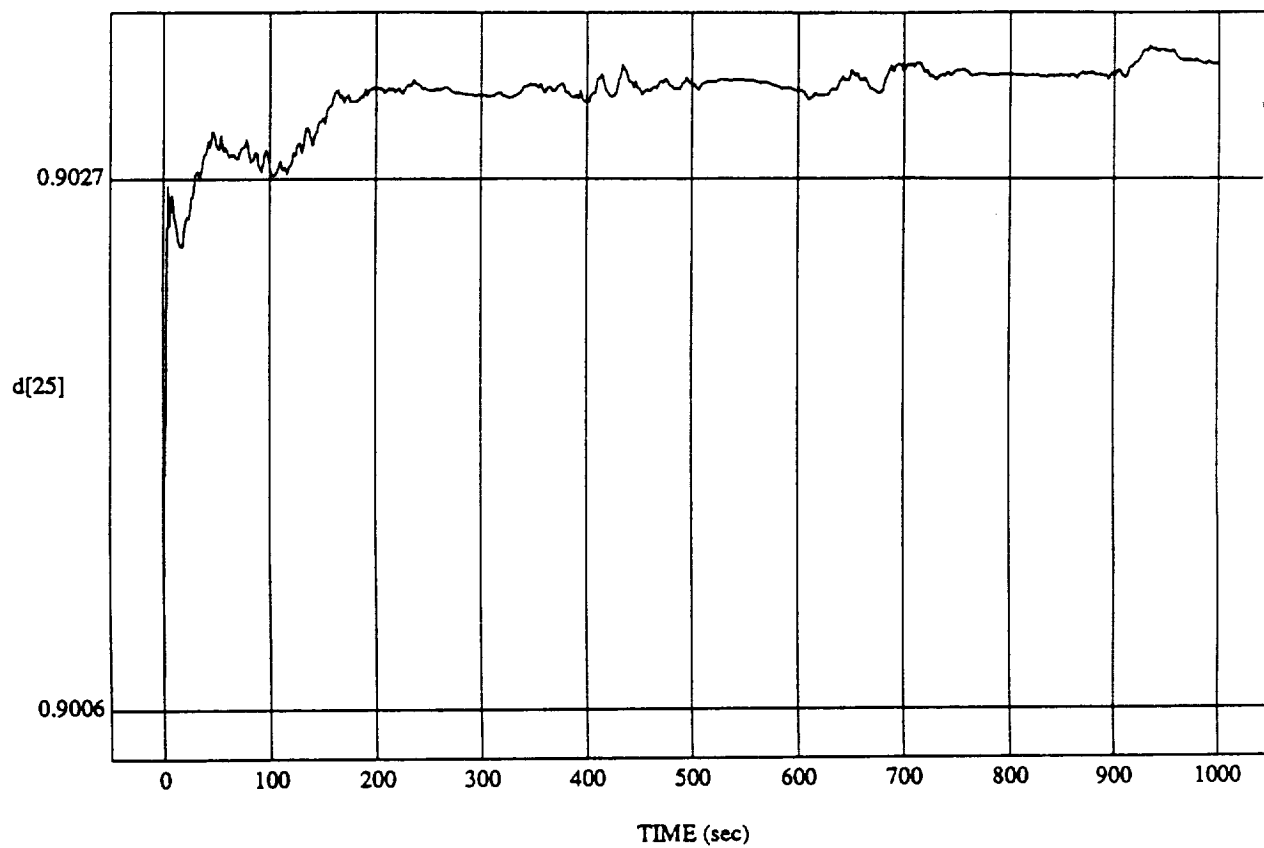


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[25] vs TIME

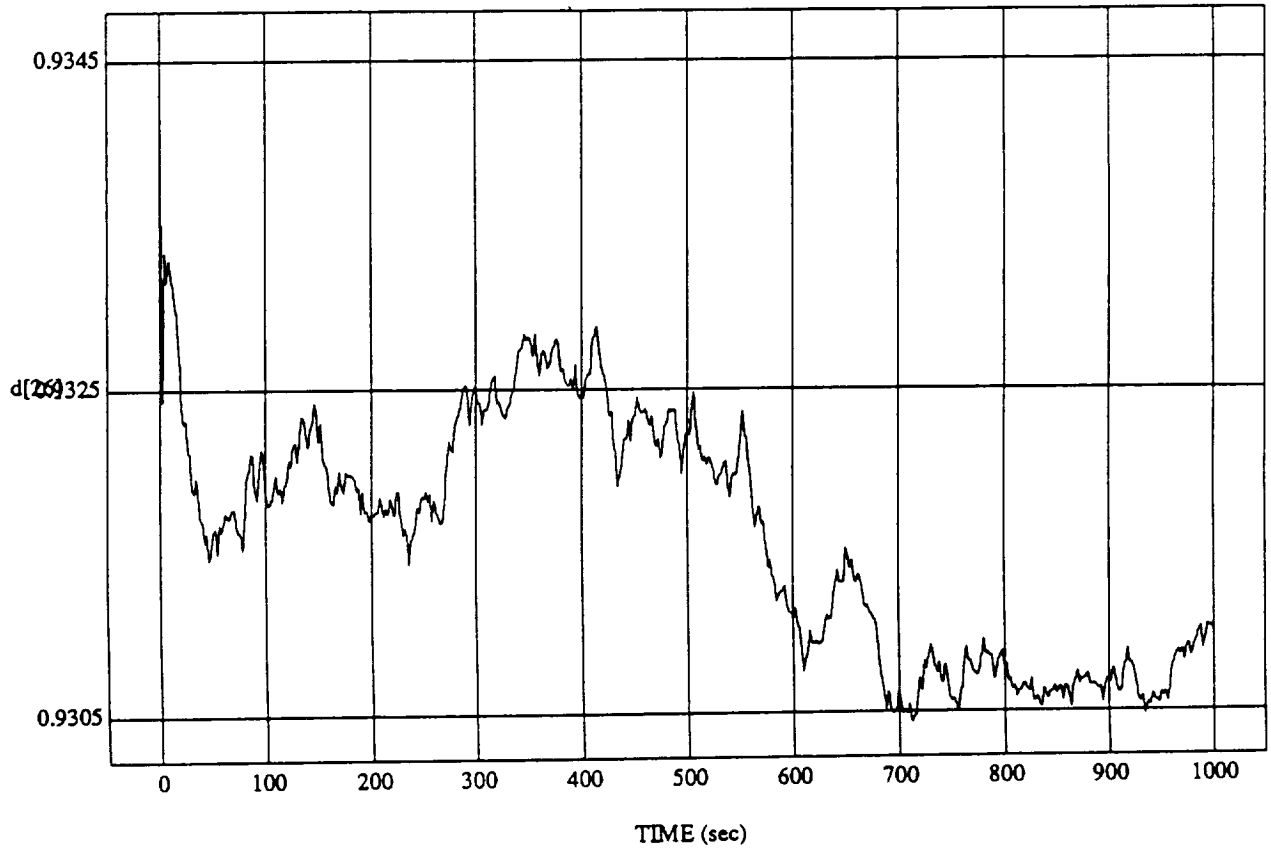
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

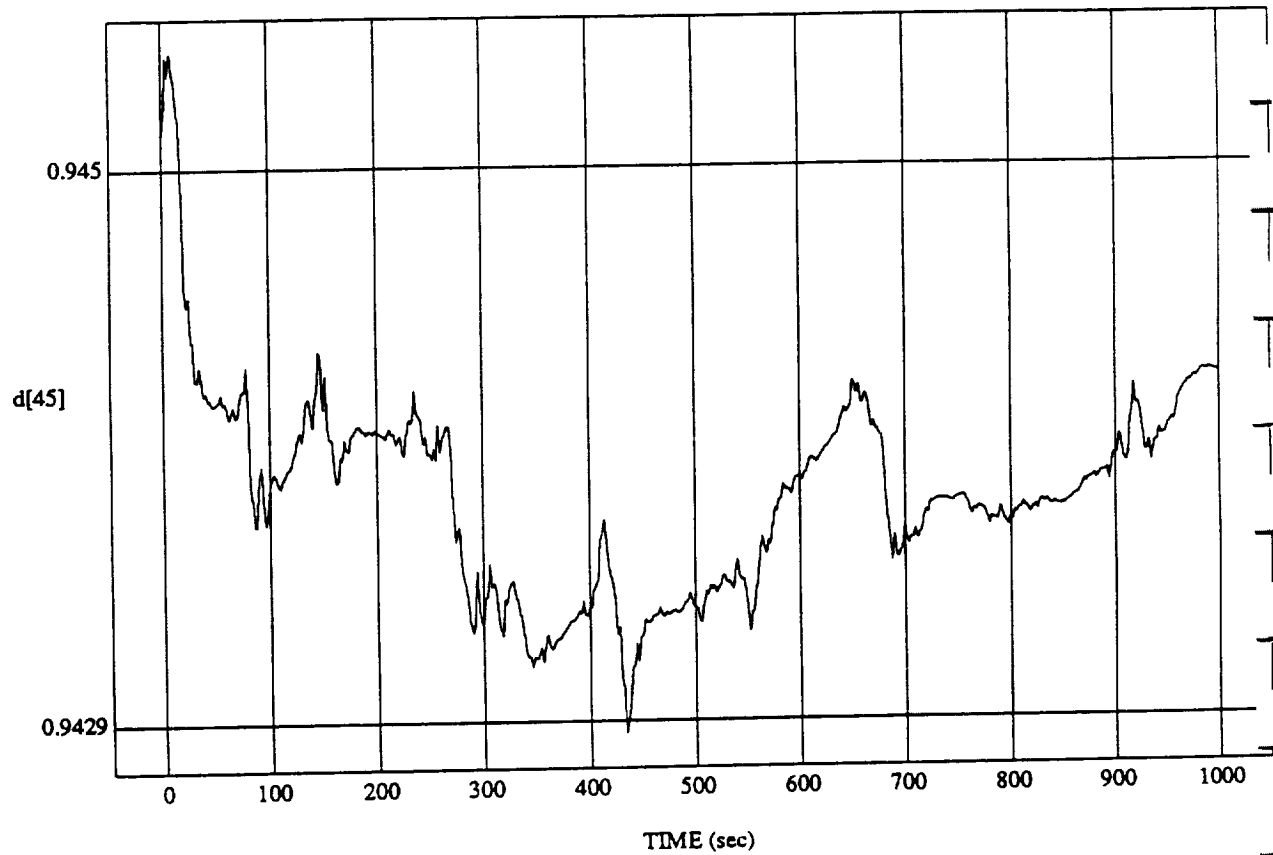
d[26] vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[45] vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



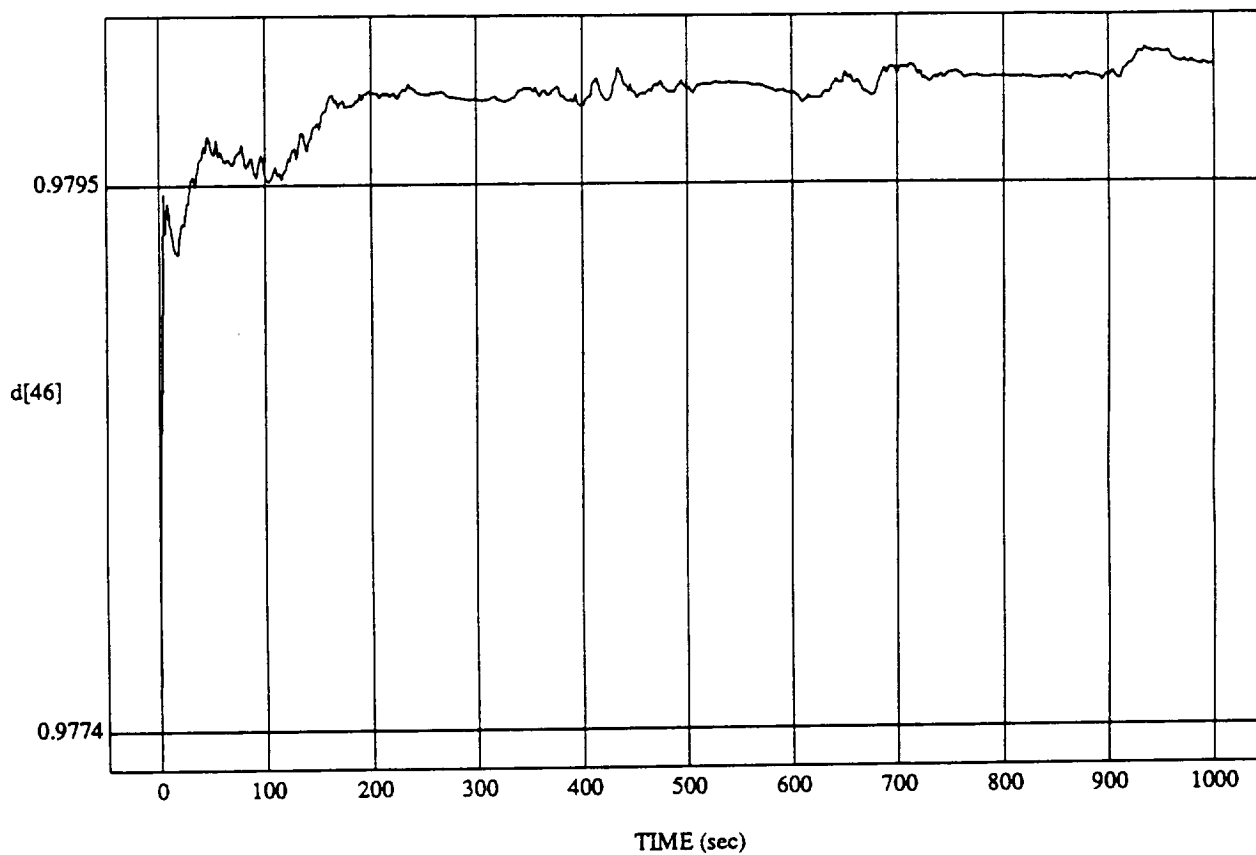
MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[46] vs TIME

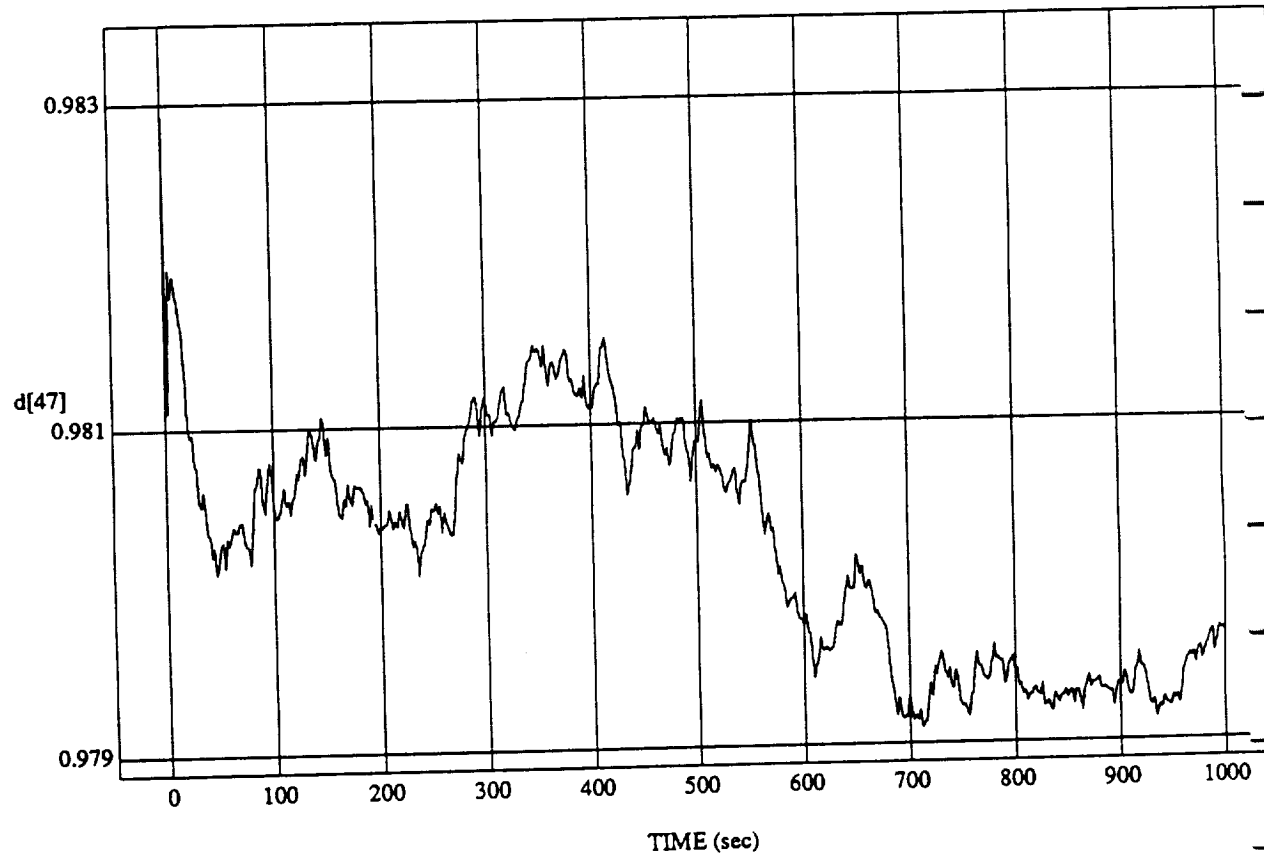
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCHlearn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

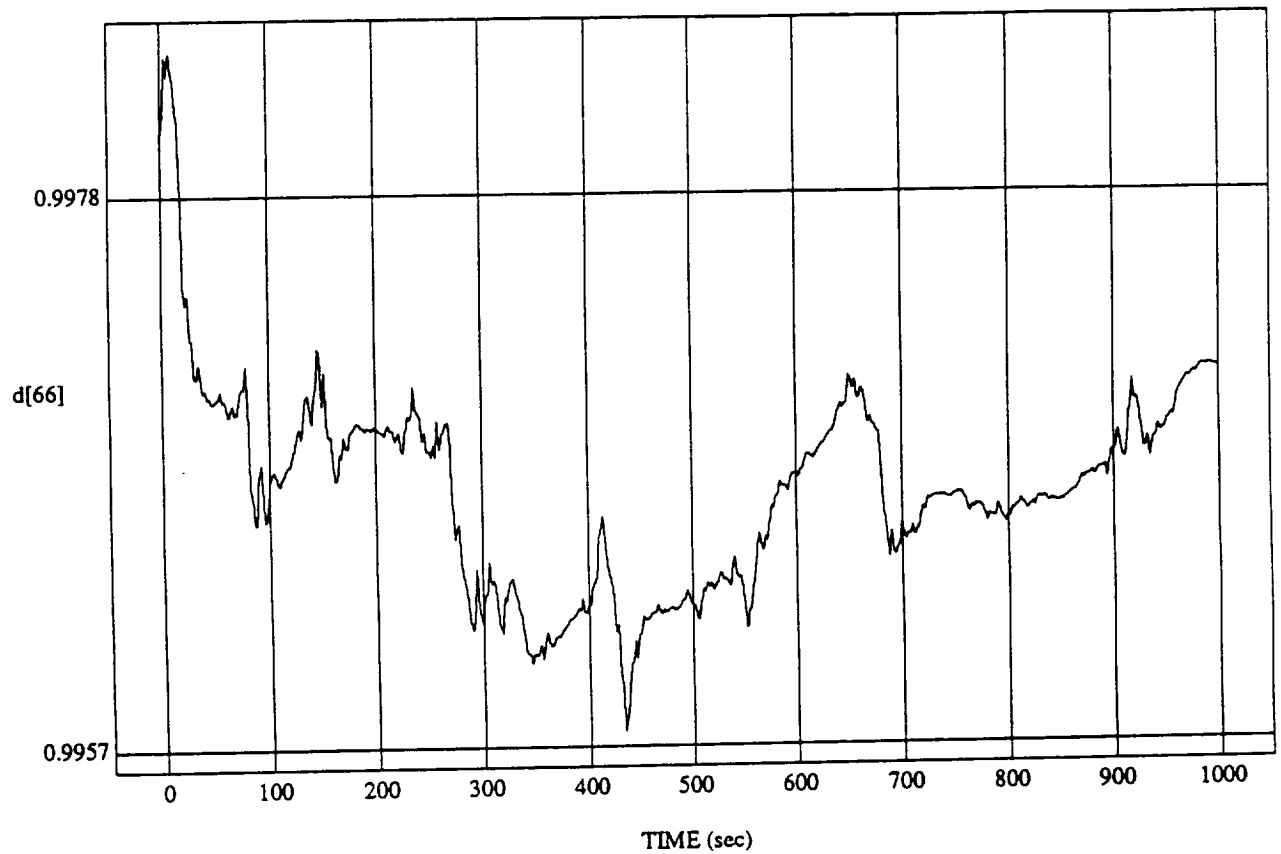
d[47] vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

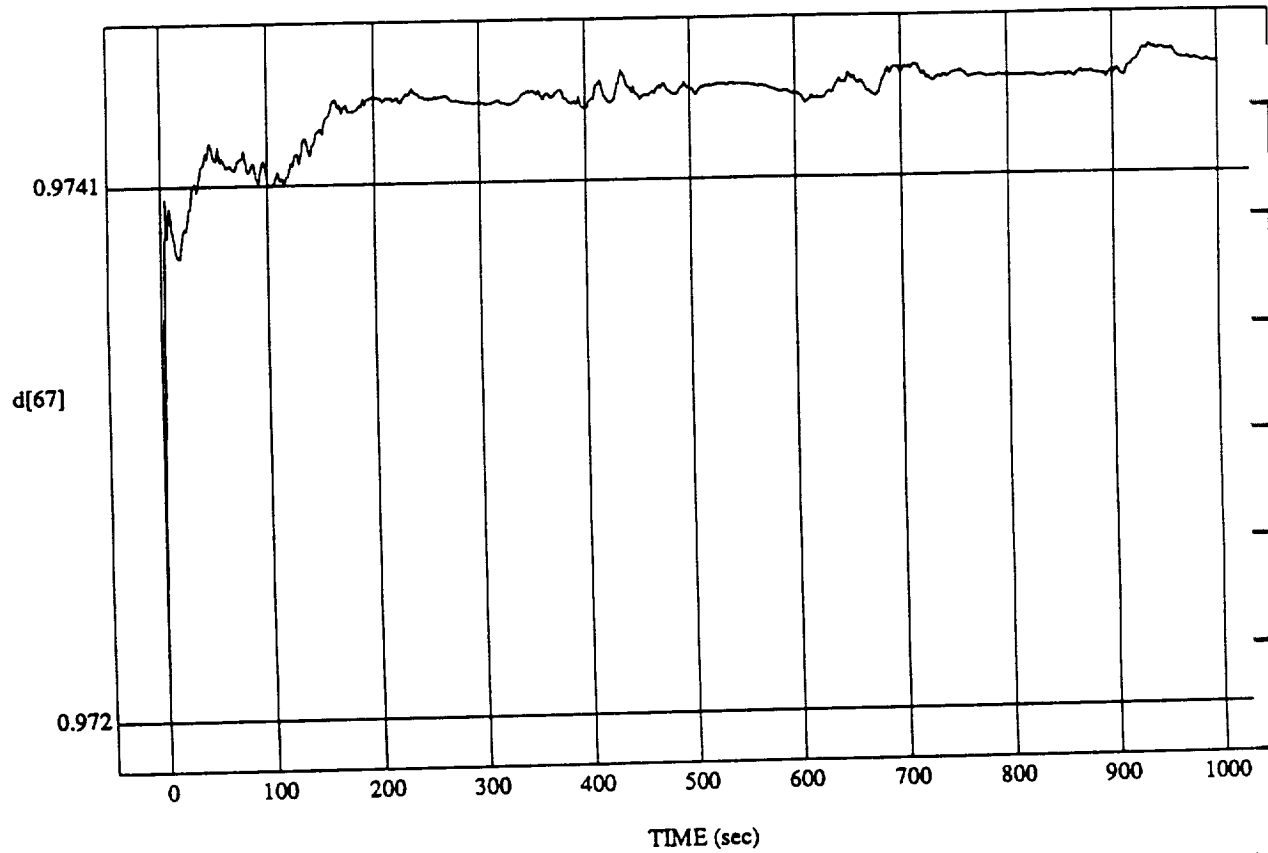
d[66] vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.1cam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

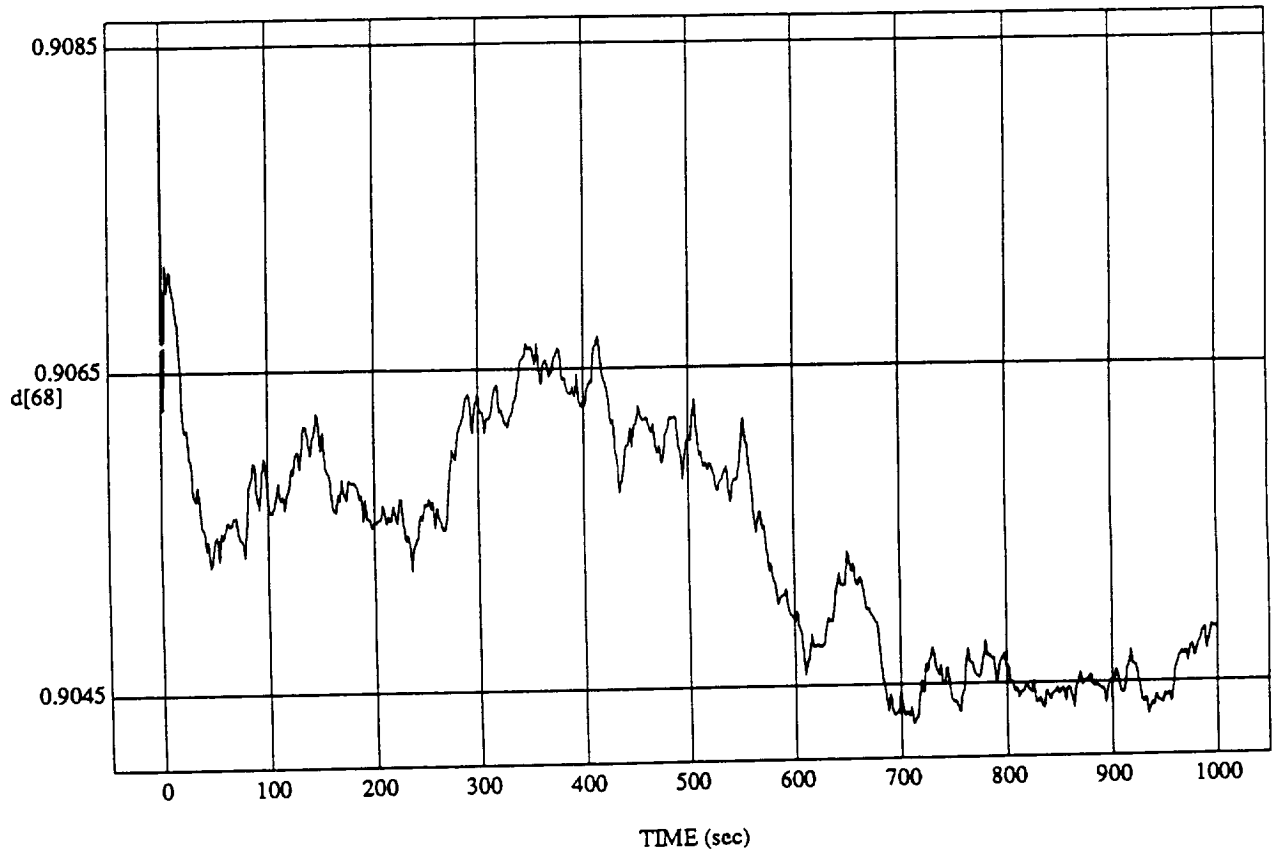
d[67] vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

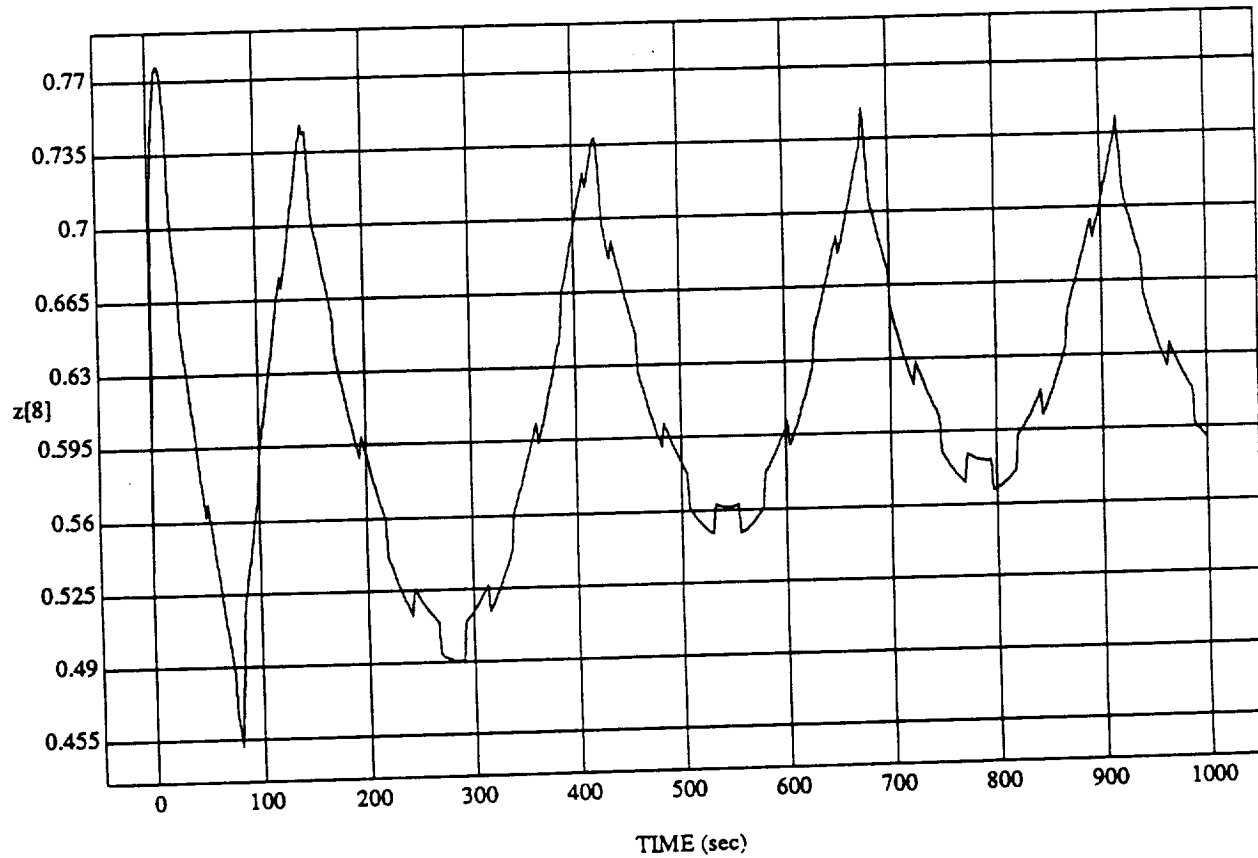
d[68] vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

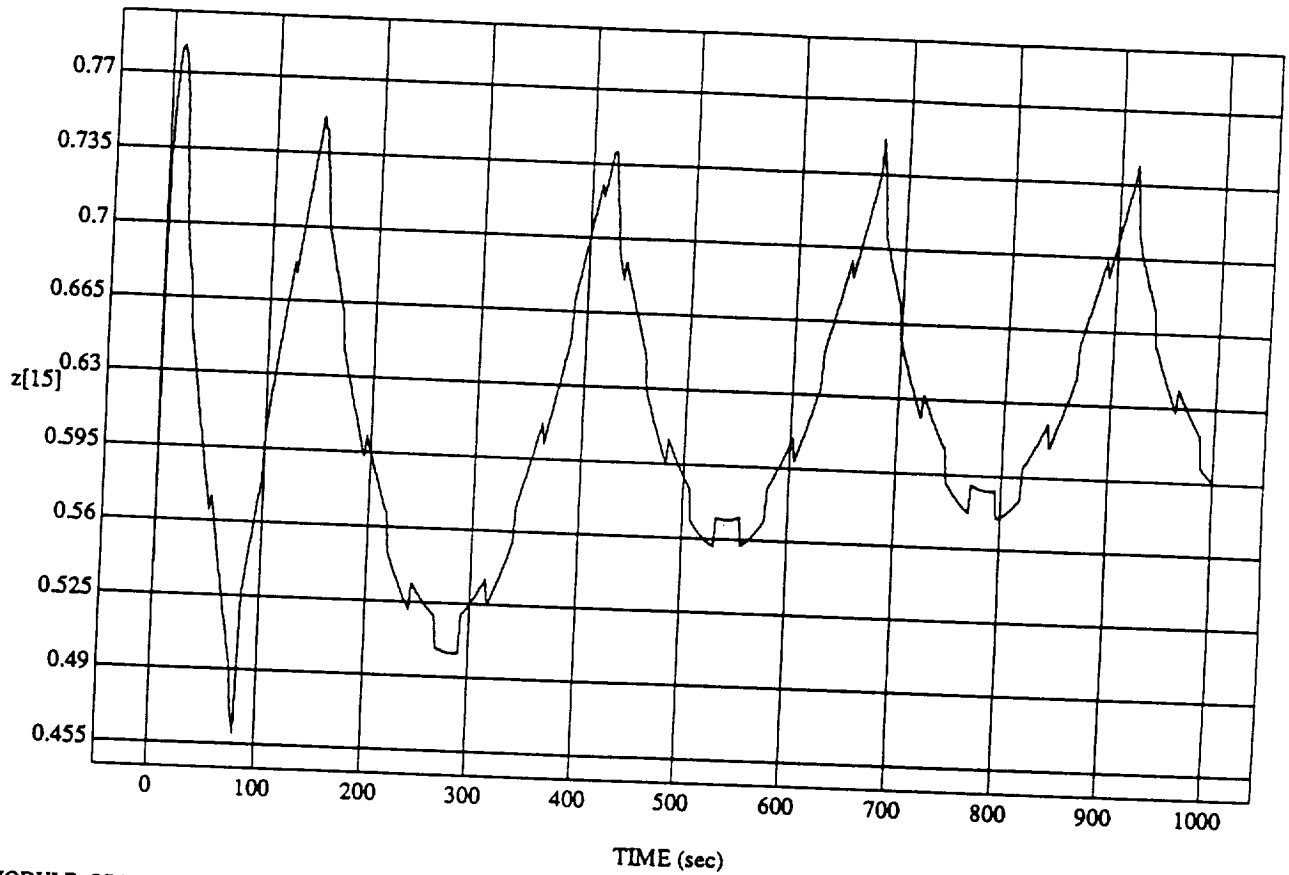
$z[8]$  vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

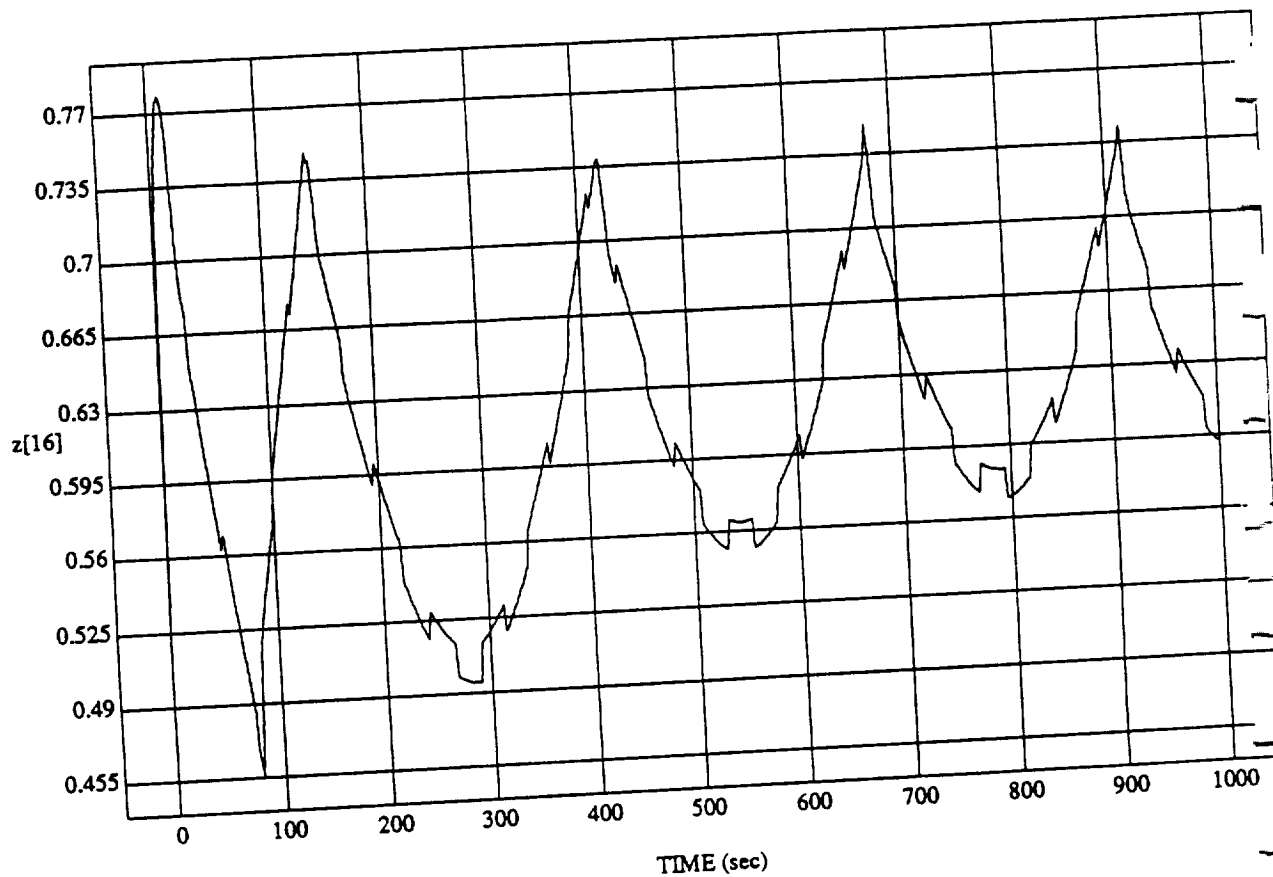
$z[15]$  vs TIME  
RUN: Normalized By Rules (Only) -  $\rho_h$  At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

z[16] vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

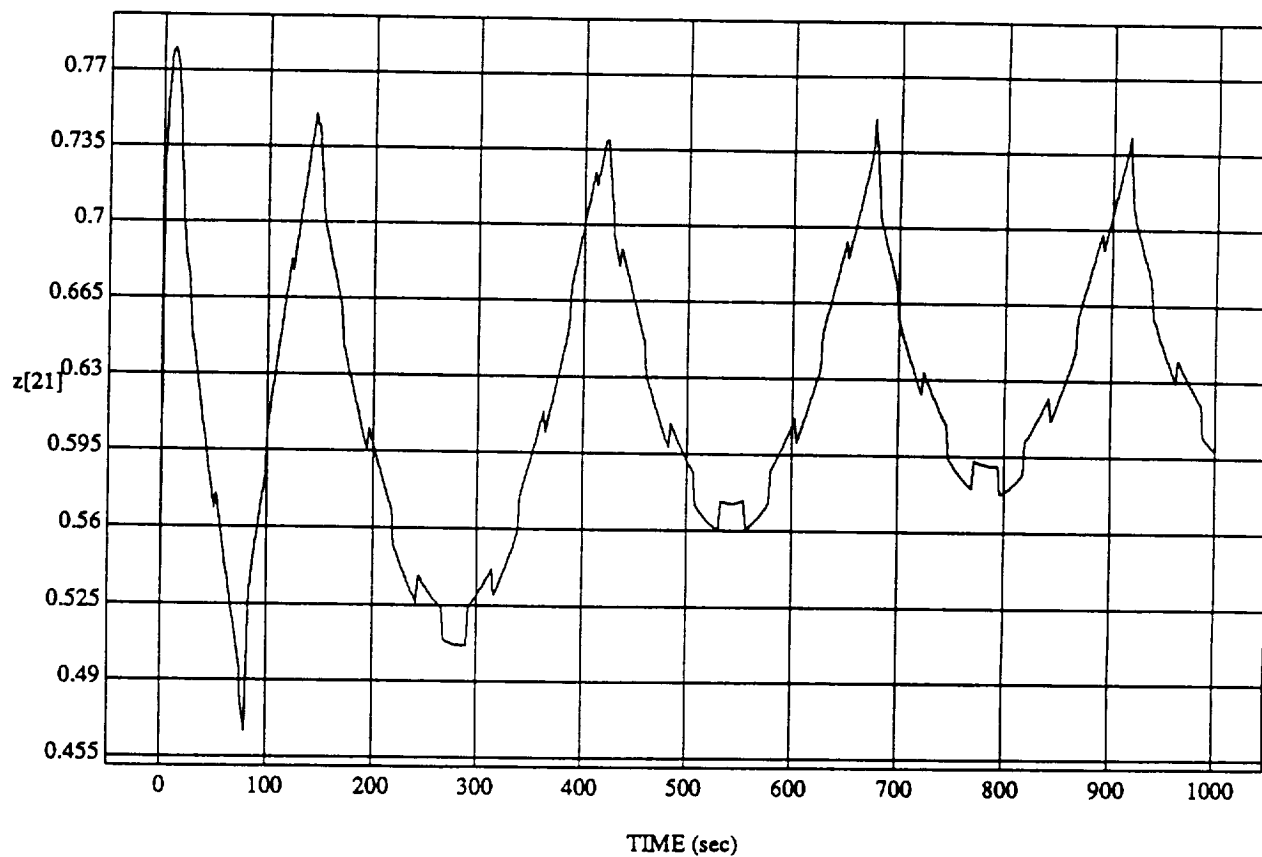
ORBITAL OPERATIONS SIMULATOR

C-4



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

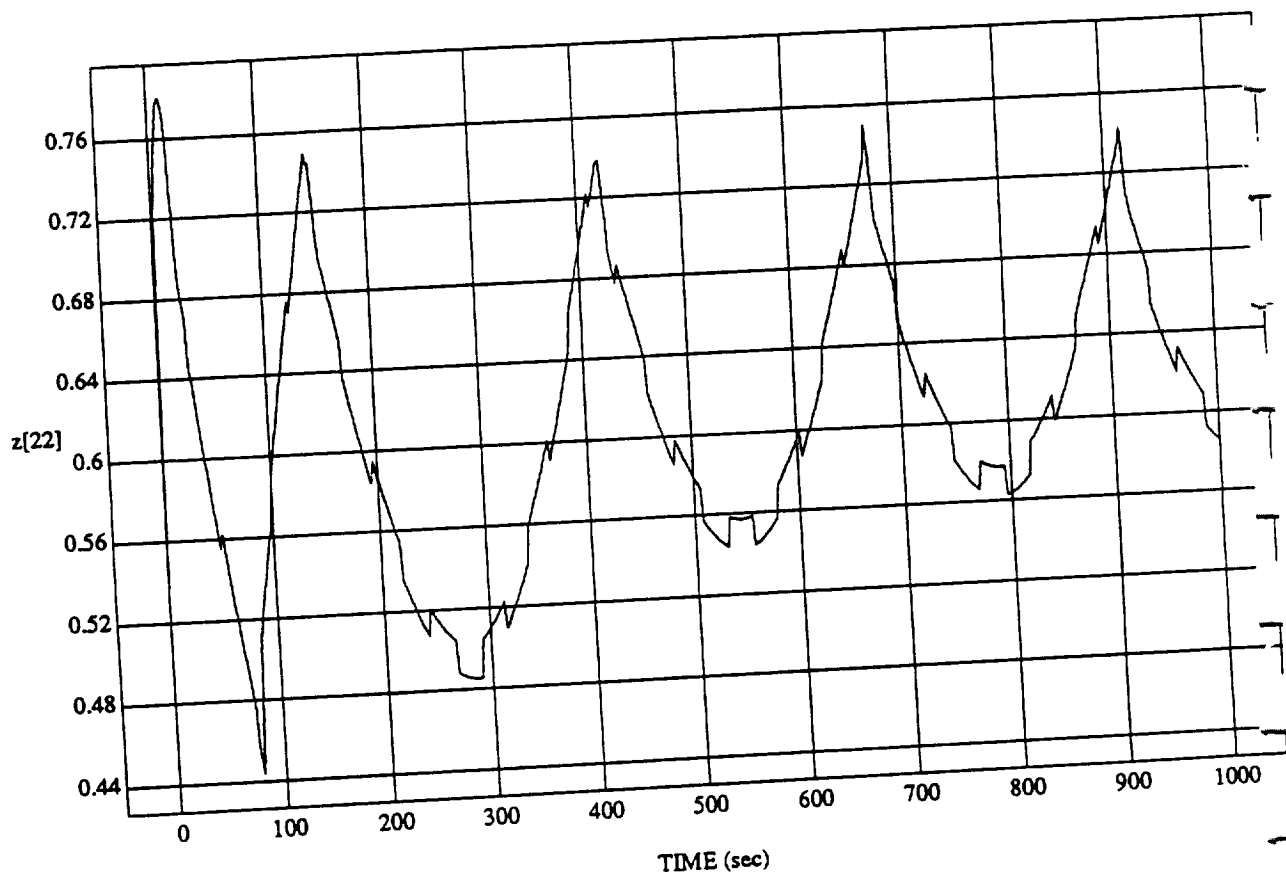
$z[21]$  vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

z[22] vs TIME  
RUN: Normalized By Rules (Only) - Rho\_h At 0.8 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.1cam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

ORBITAL OPERATIONS SIMULATOR

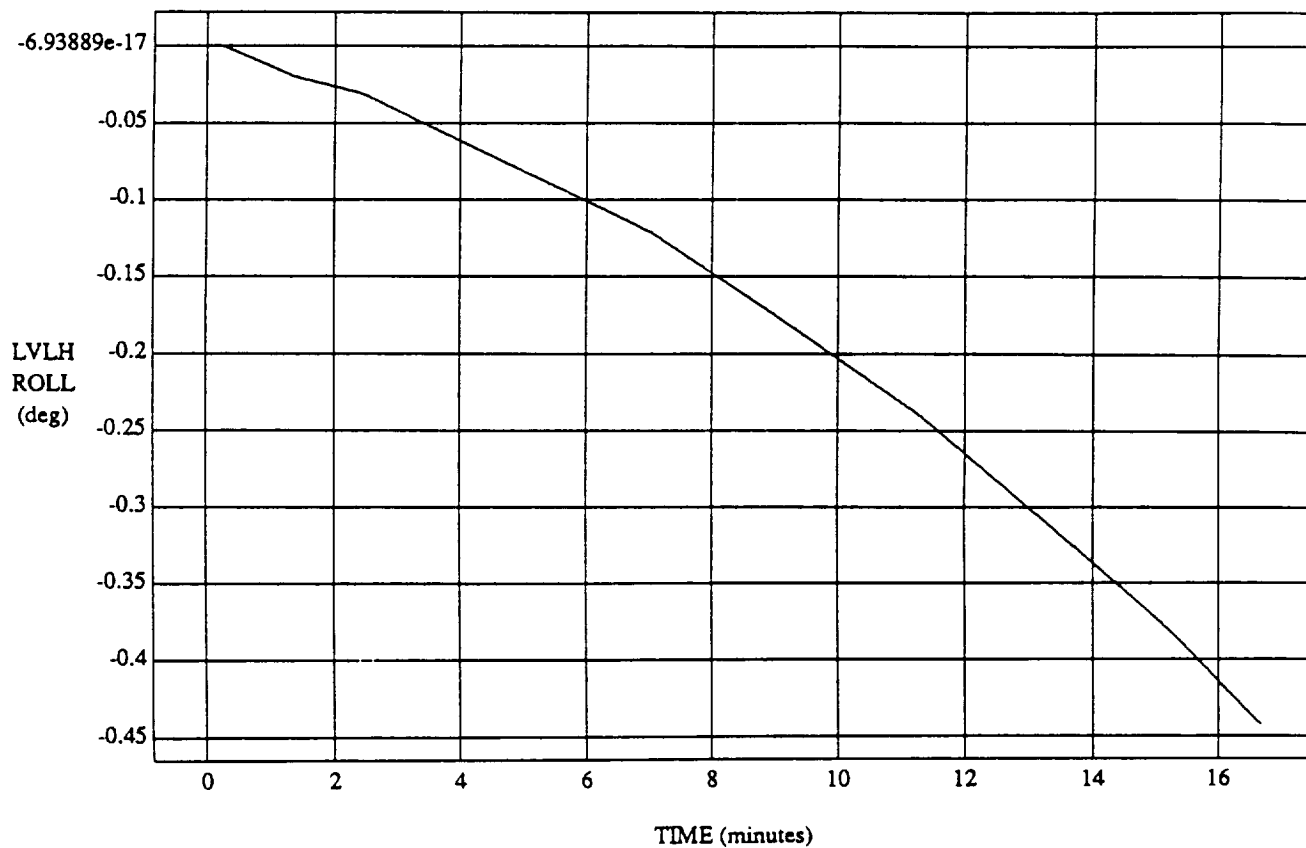




XI

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

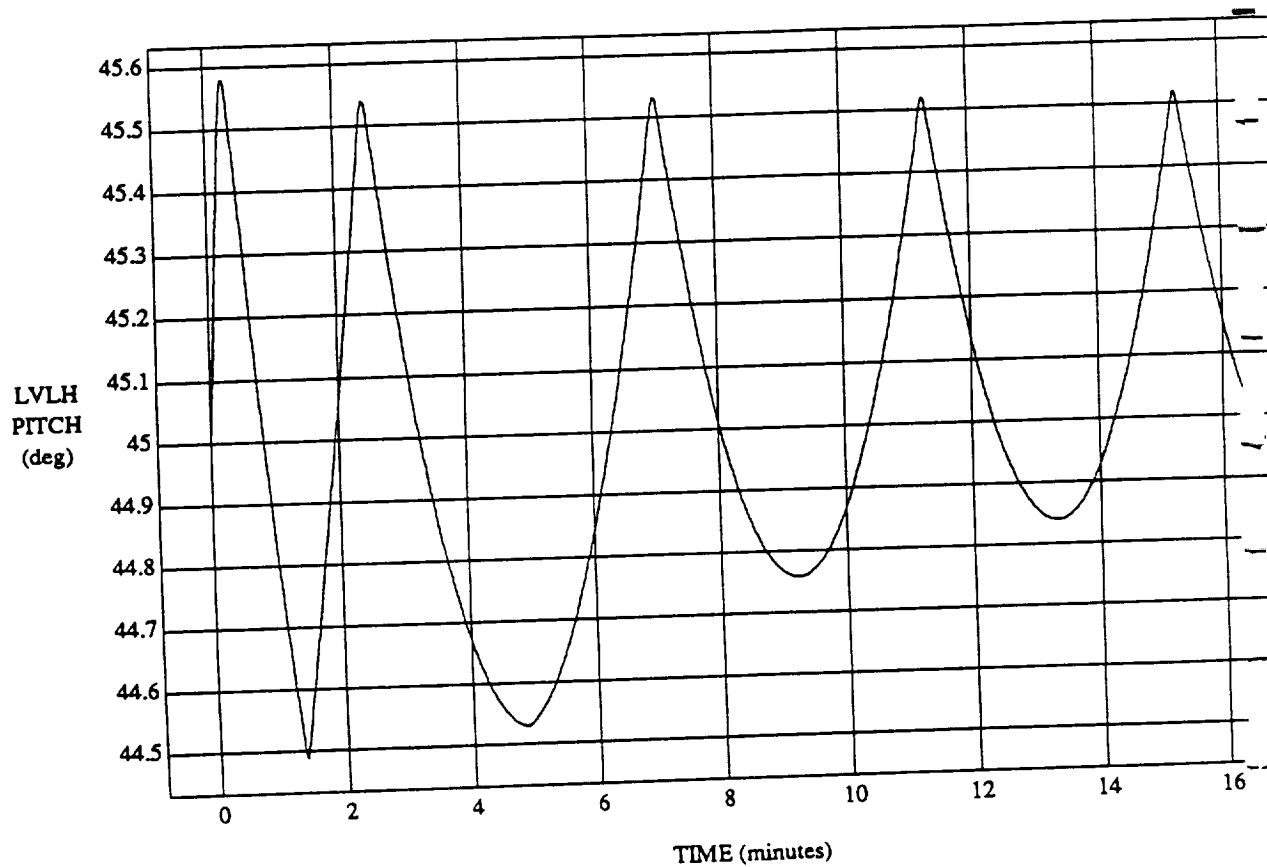
LVLH EULER PYR ROLL vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

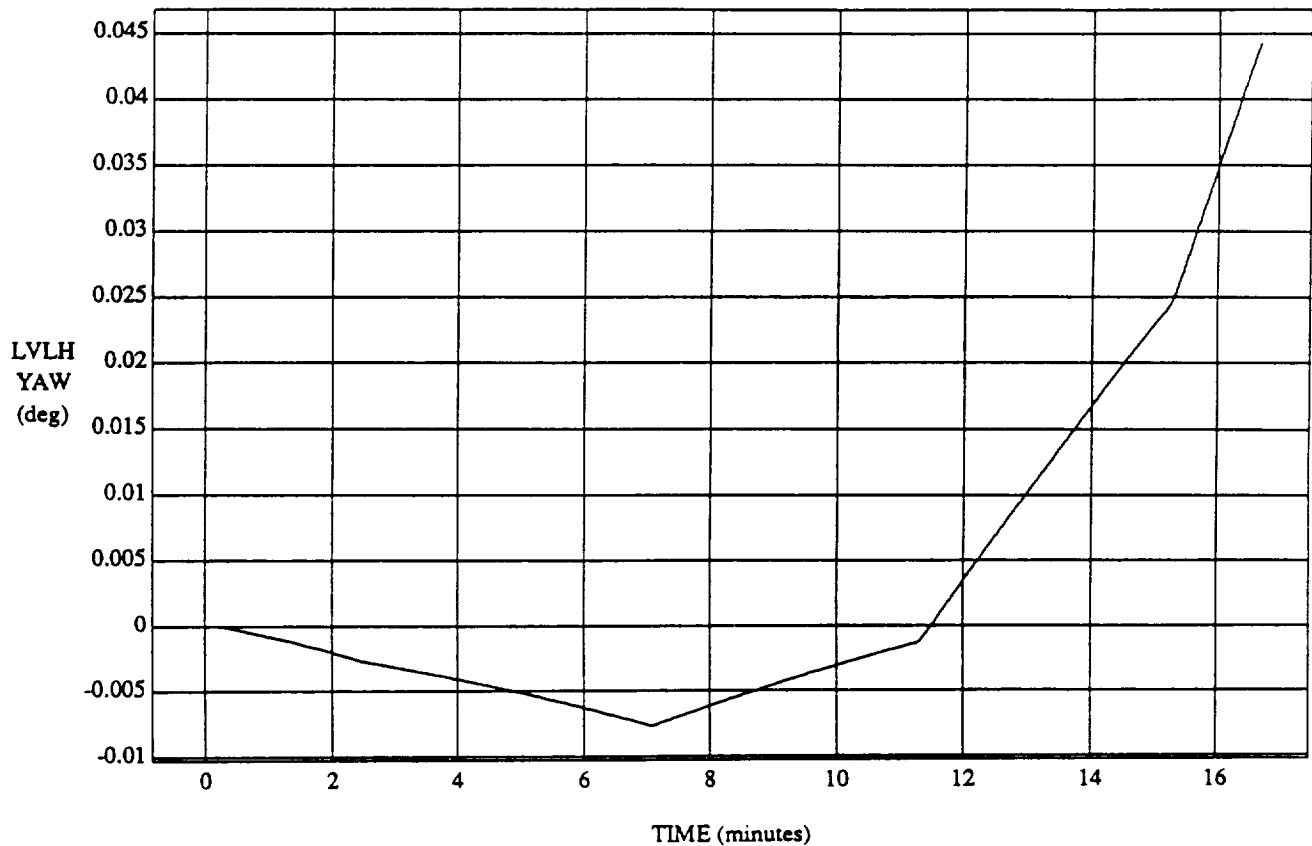
SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH EULER PYR PITCH vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

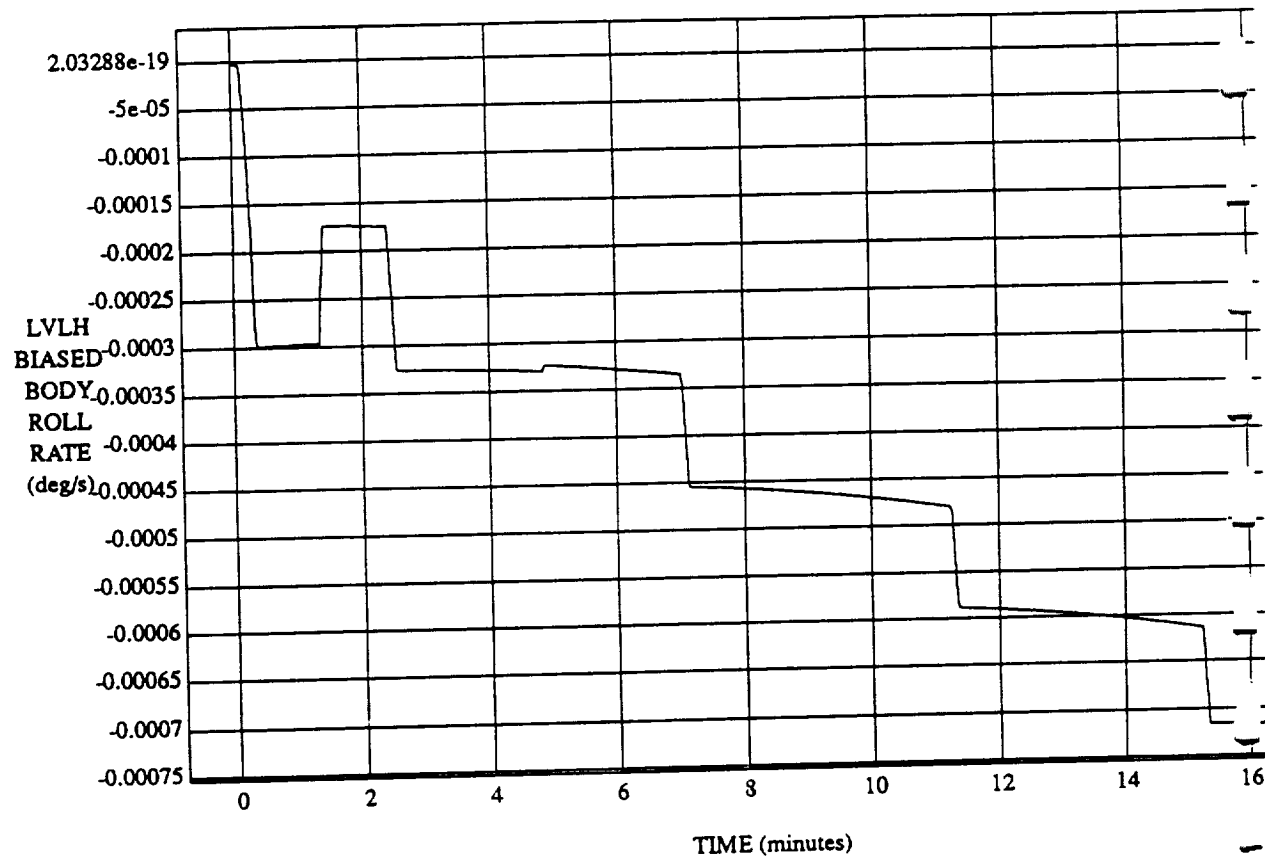
LVLH EULER PYR YAW vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

LVLH BIASED BODY ROLL RATE vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



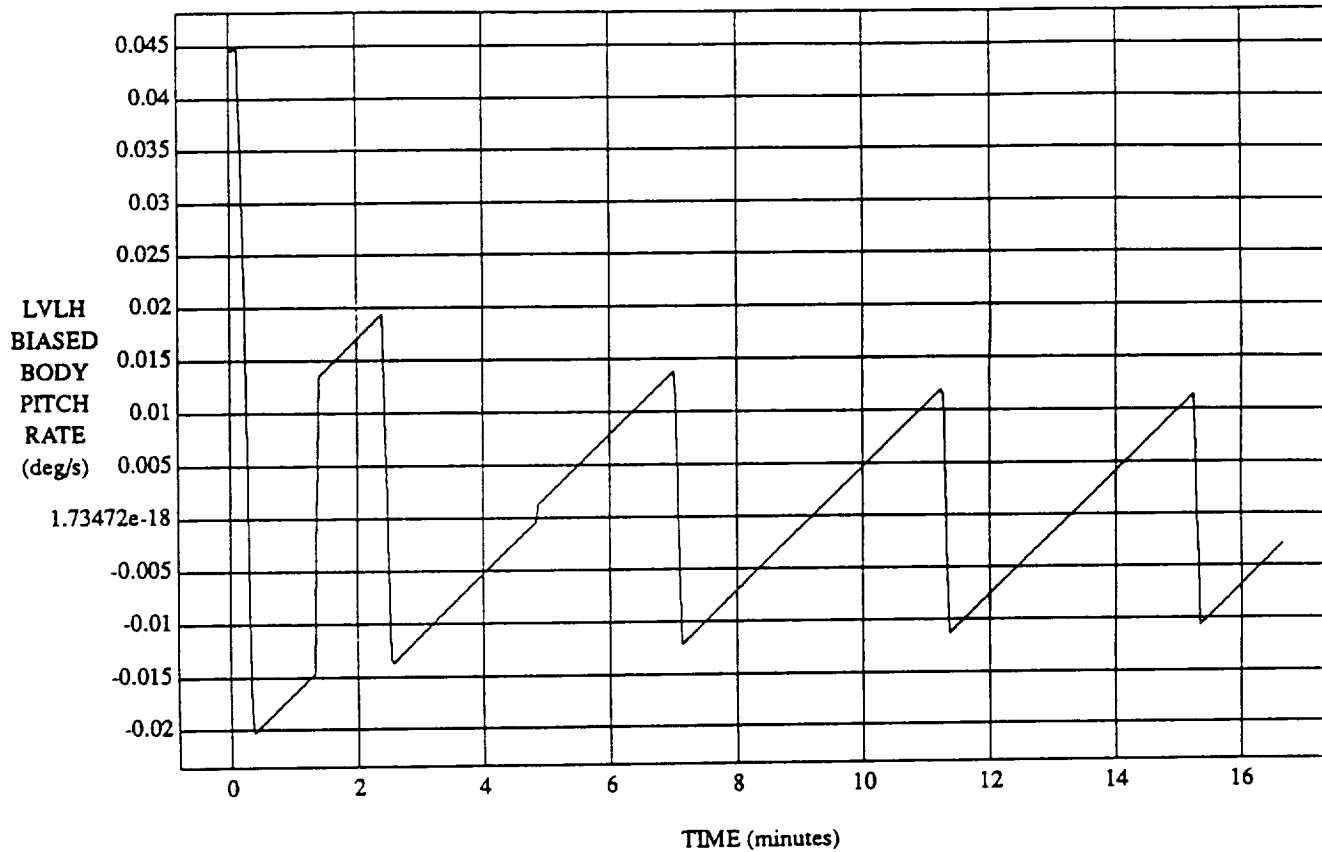
VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

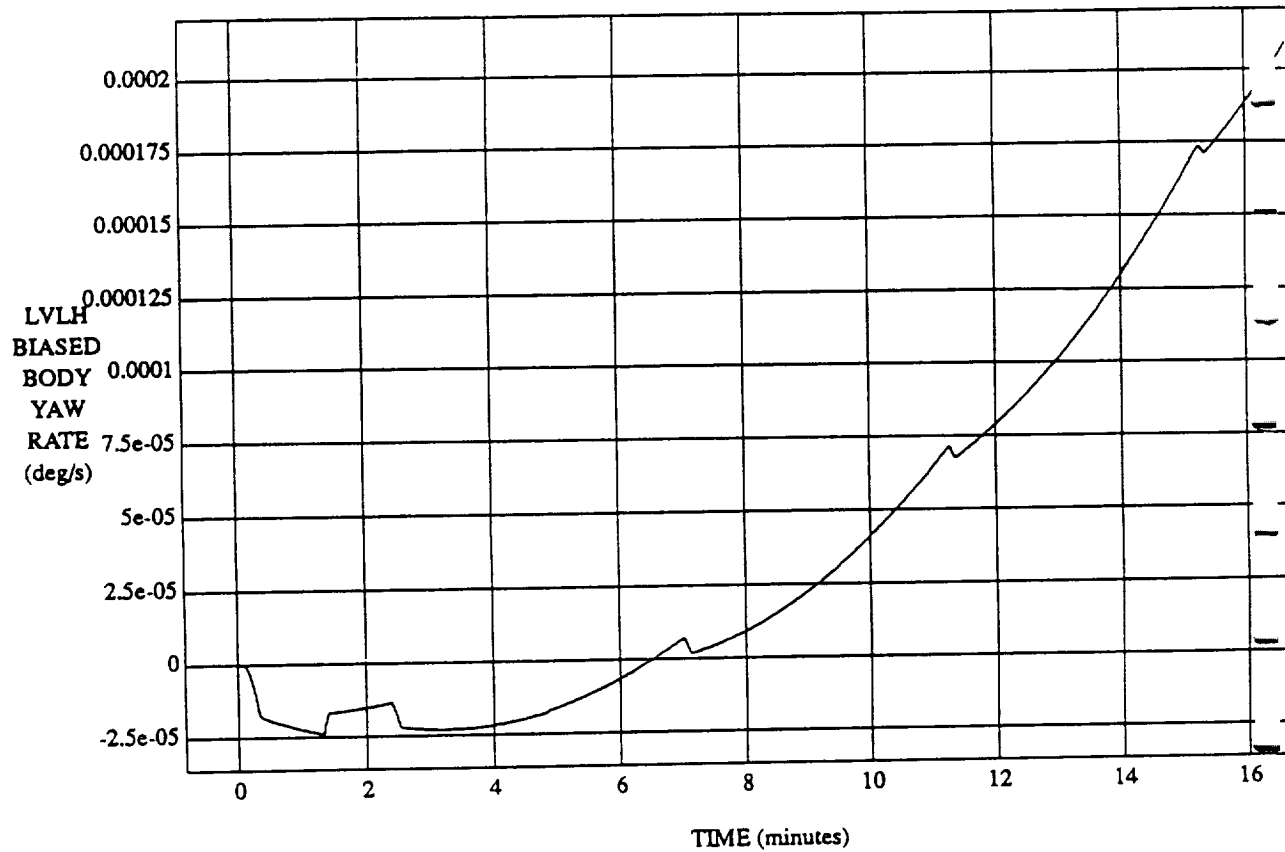
LVLH BIASED BODY PITCH RATE vs TIME

RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

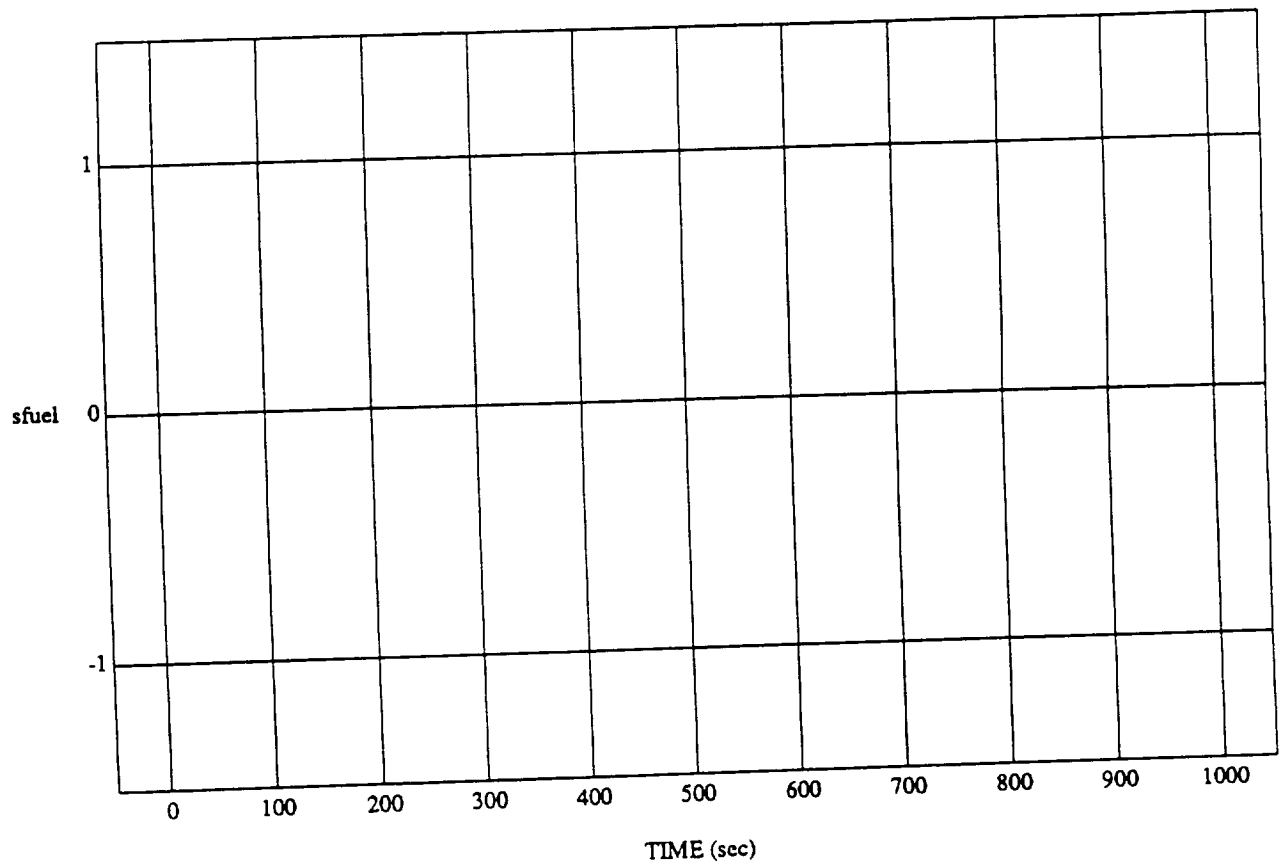
**LVLH BIASED BODY YAW RATE vs TIME**  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992

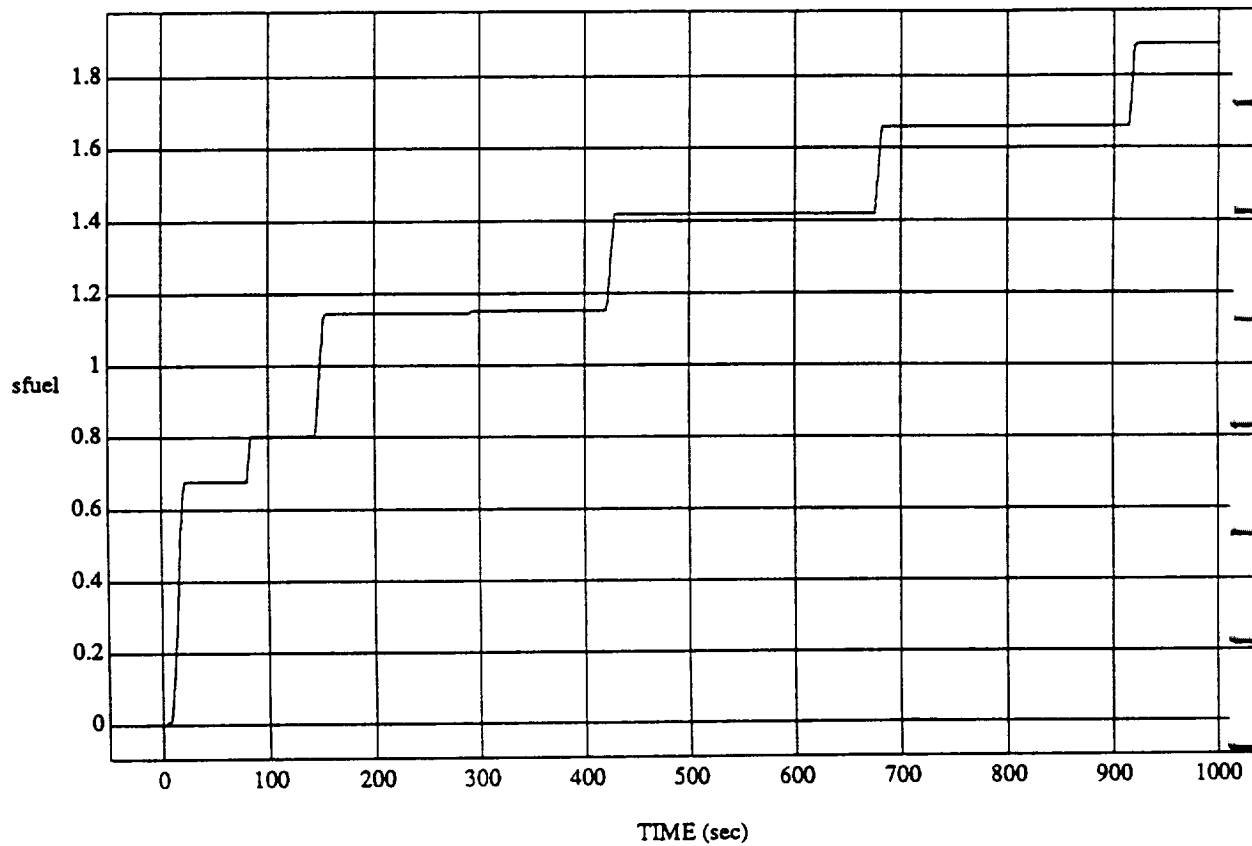


MODULE: ORB\_FUZZ\_BATCH.primary  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME

RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992

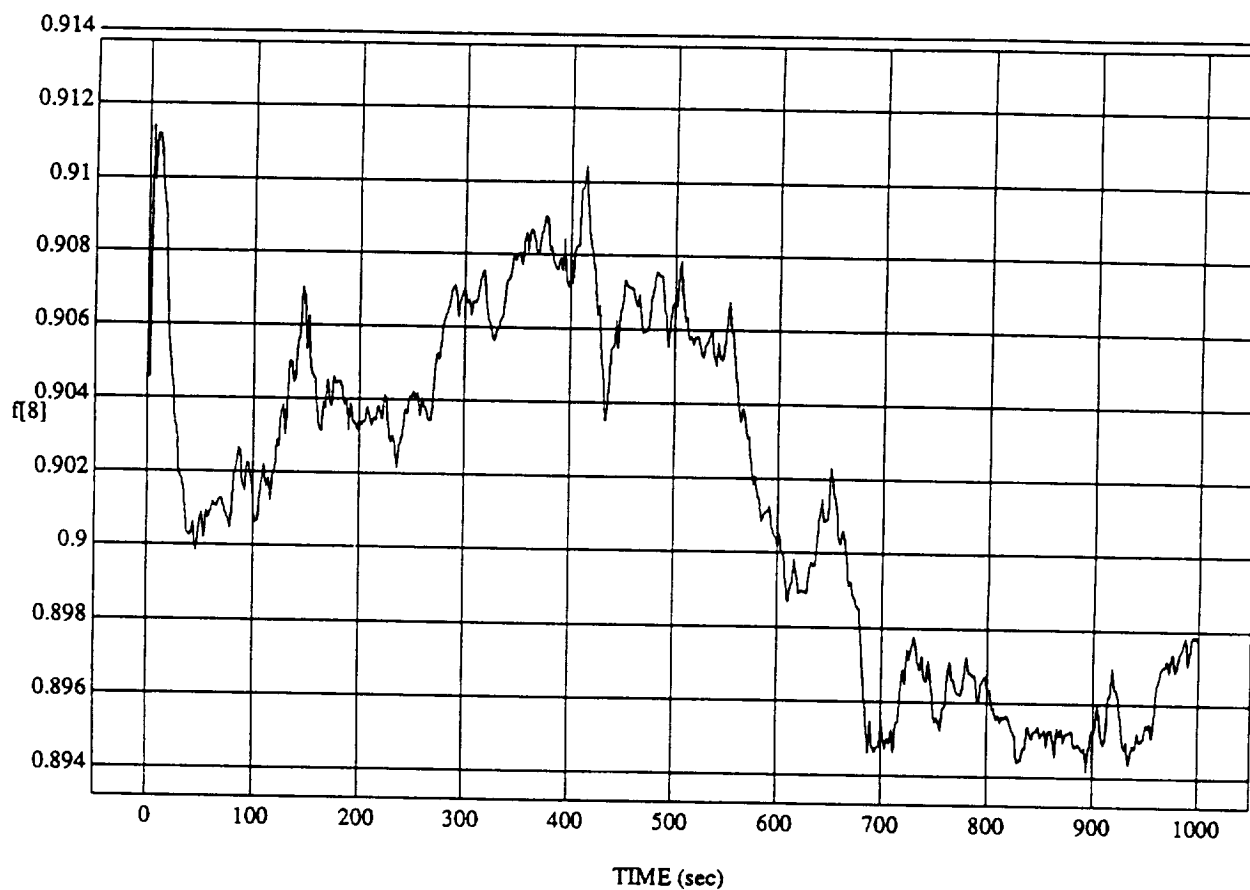


MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[8]$  vs TIME

RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992

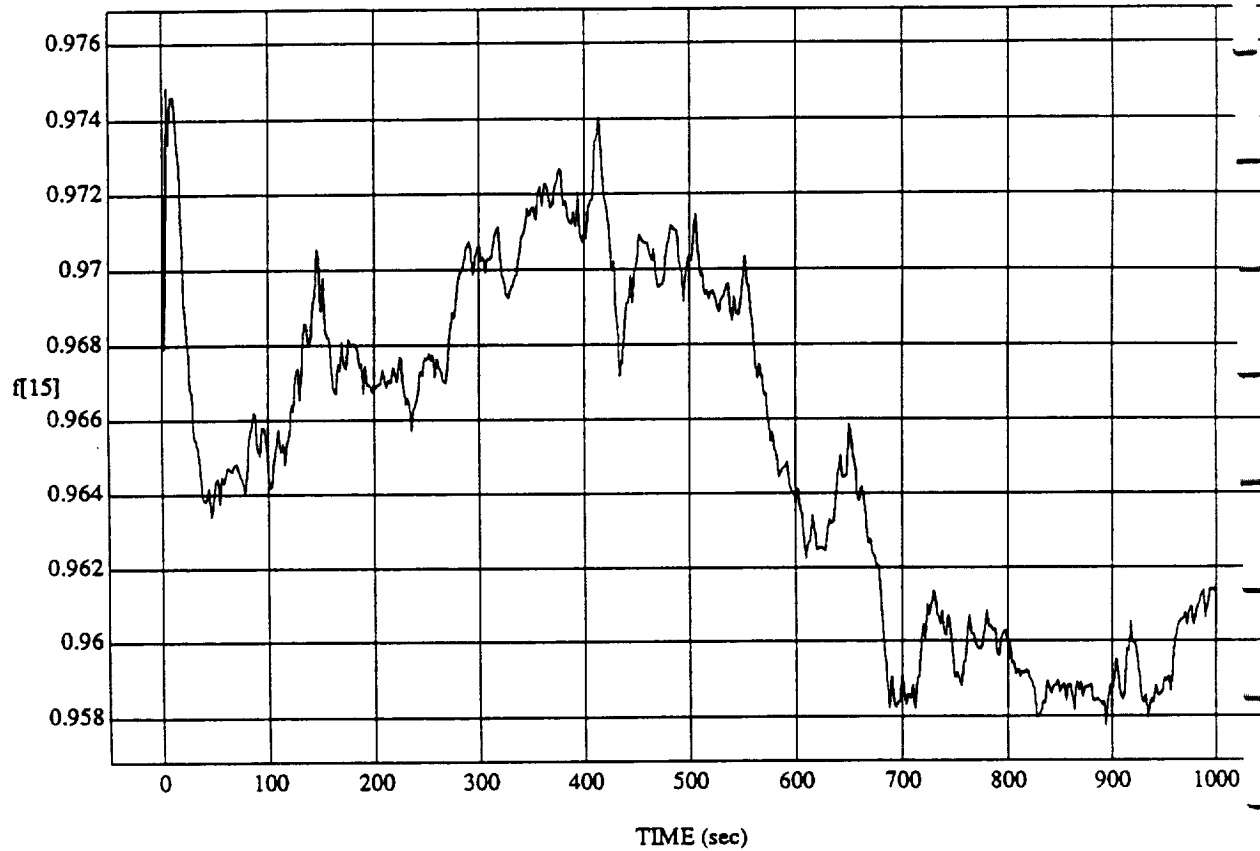


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[15] vs TIME

RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992

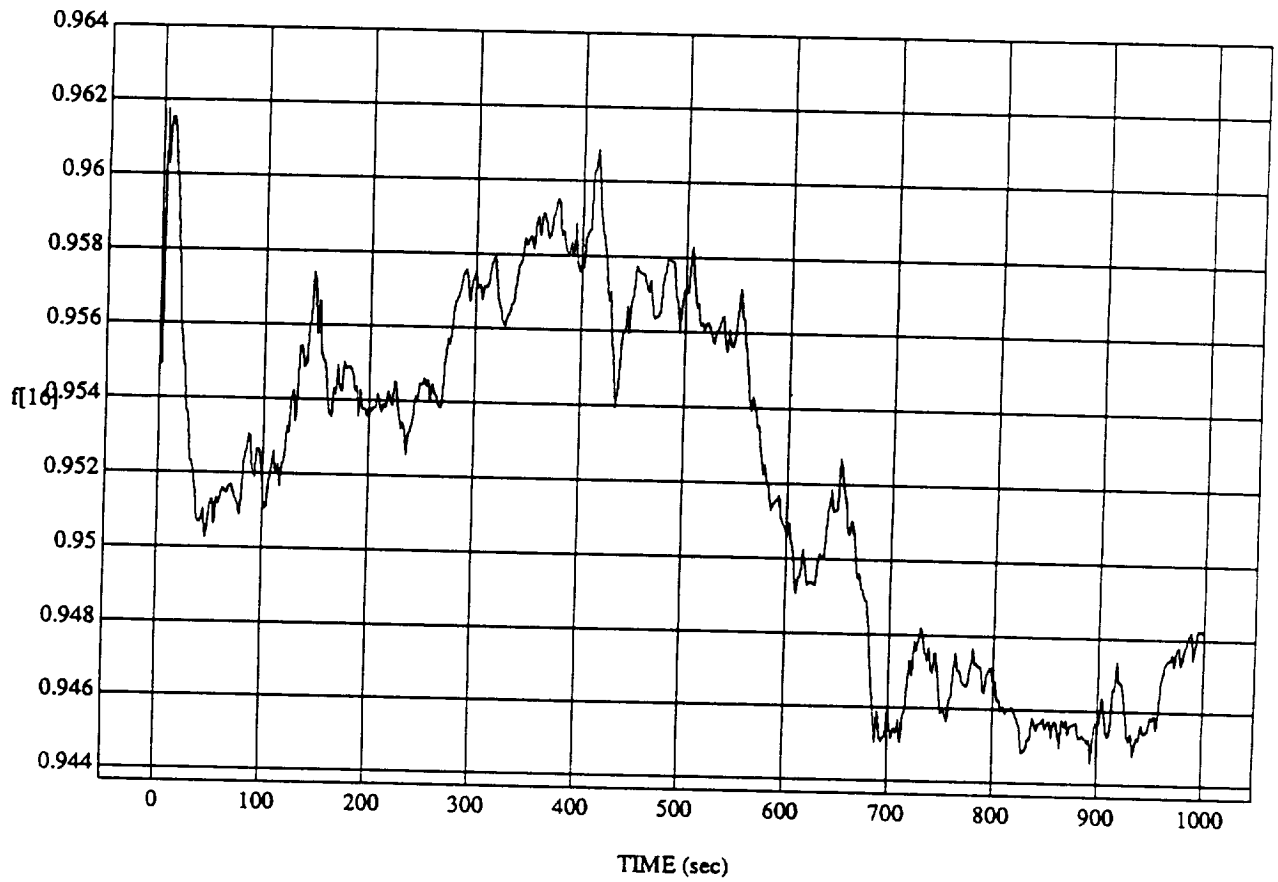


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[16] vs TIME

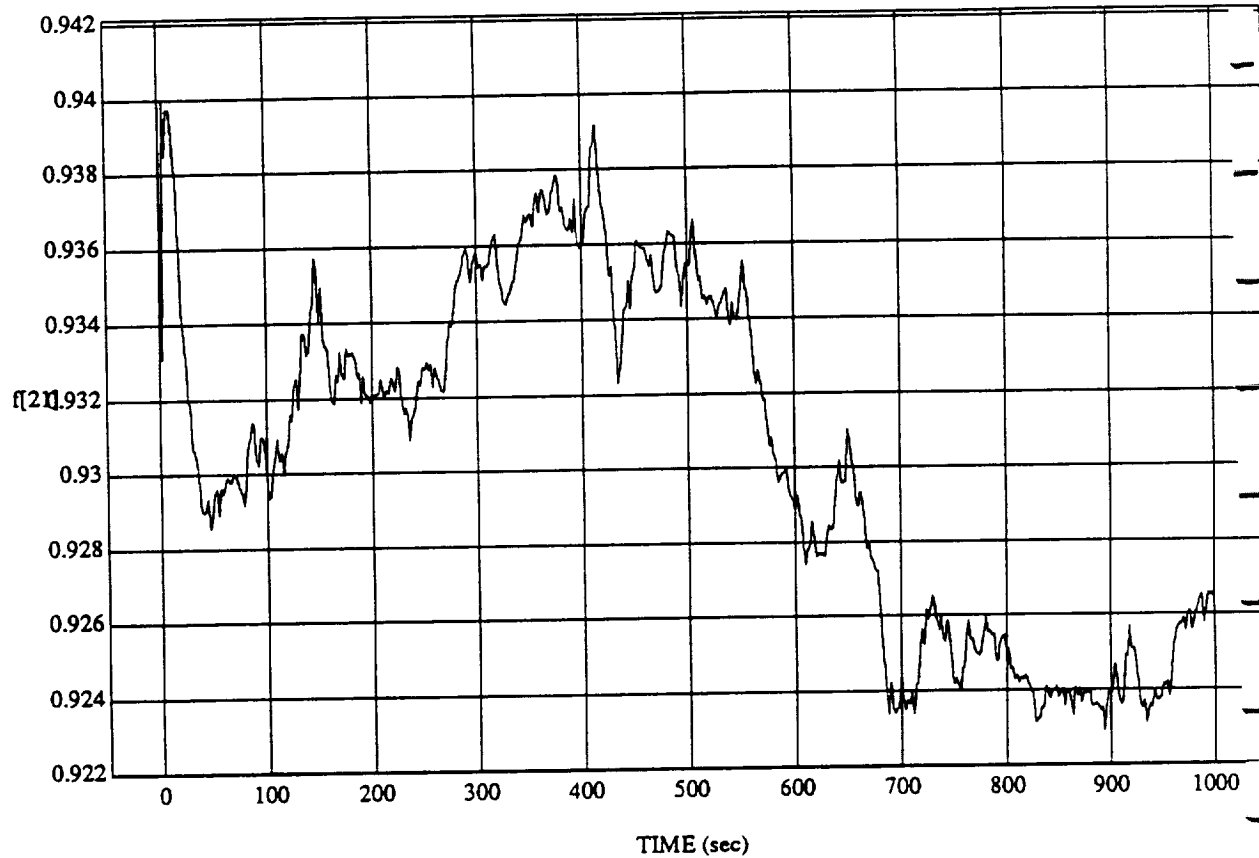
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[21] vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992

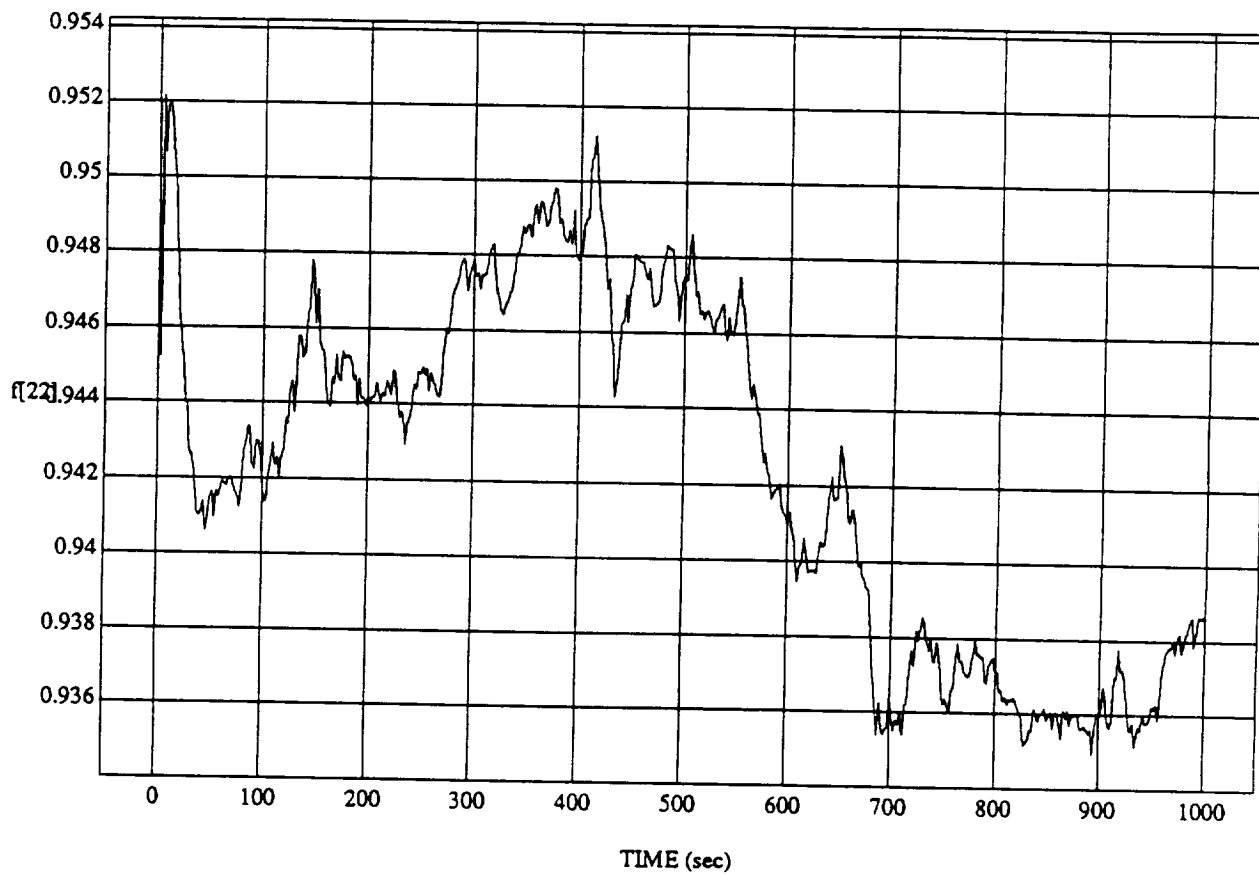


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[22] vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992

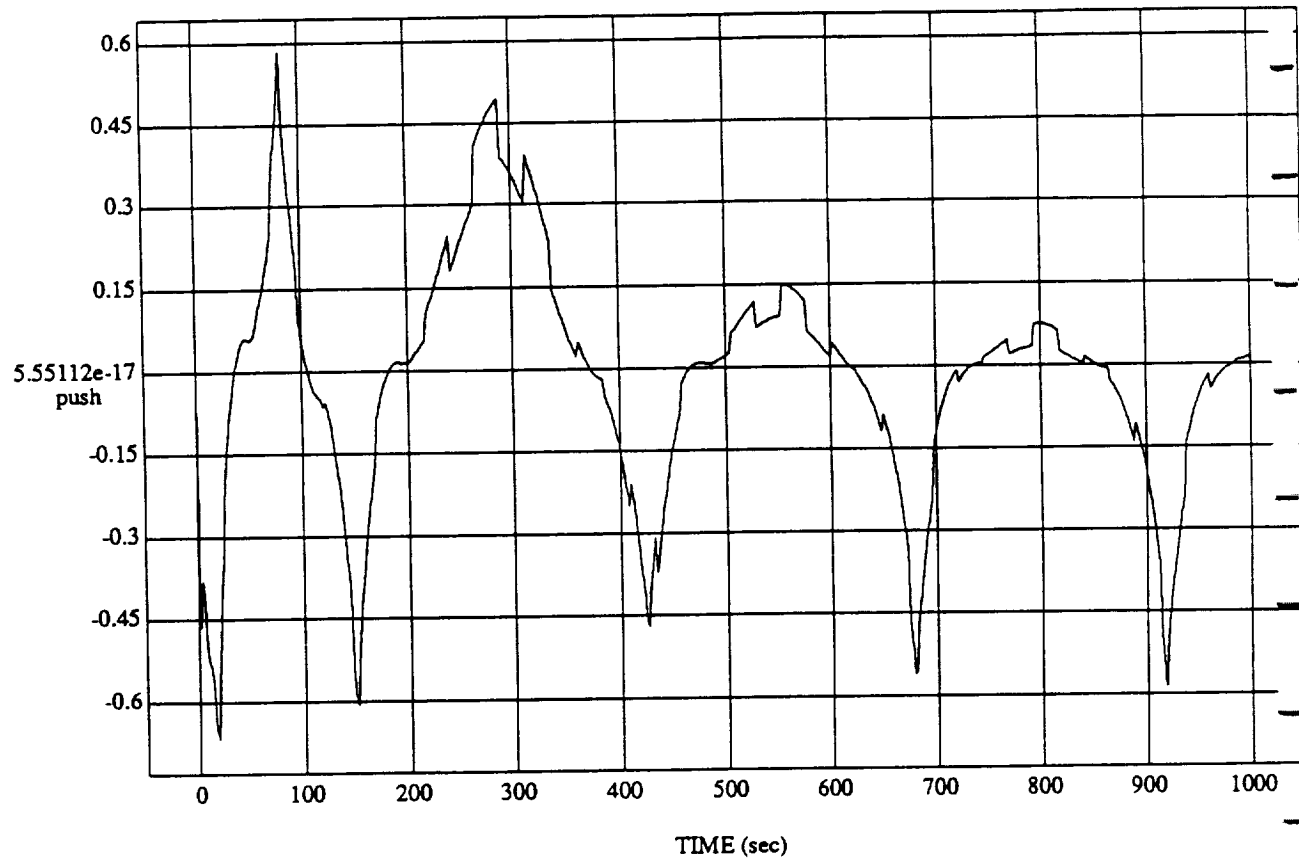


MODULE: ORB\_FUZZ\_BATCH.1cam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

push vs TIME

RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992

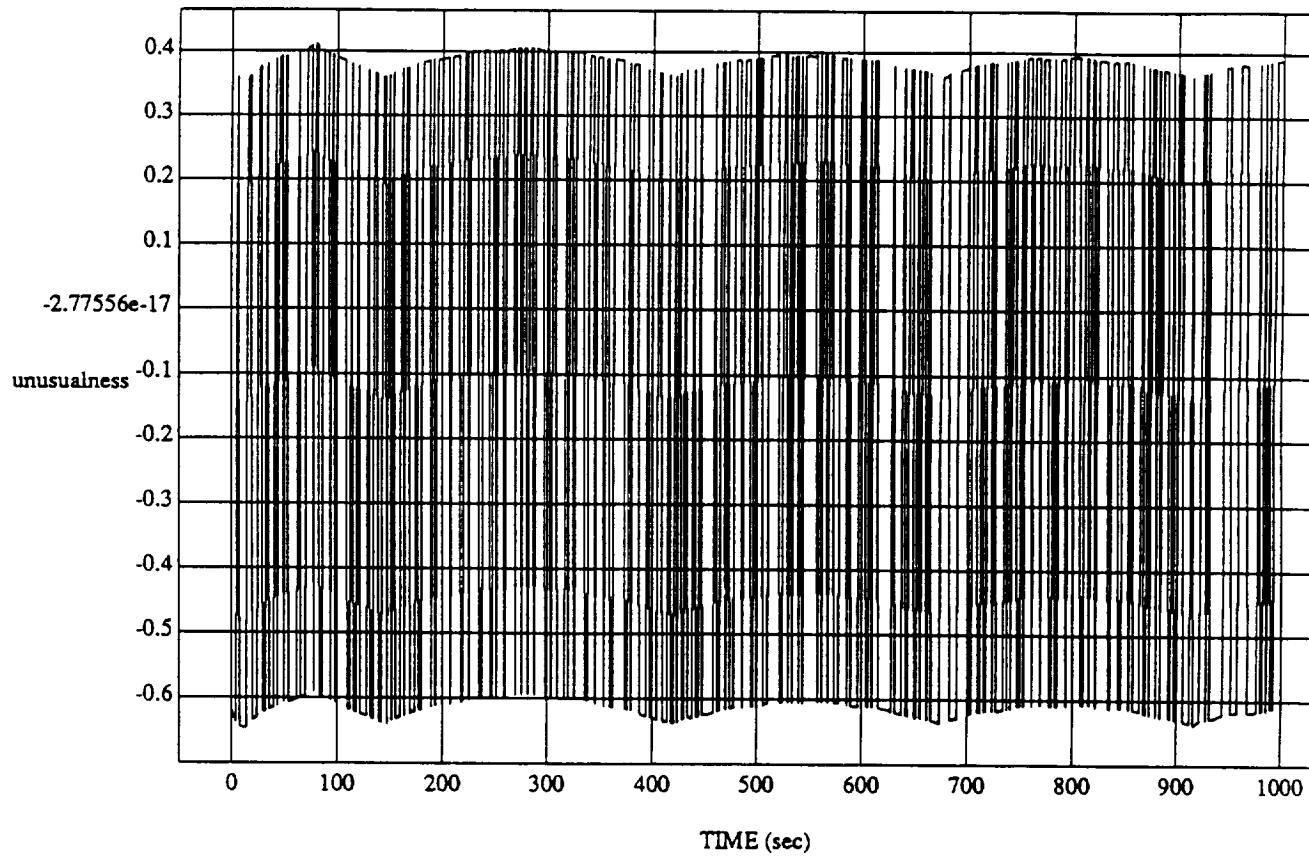


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

unusualness vs TIME

RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992

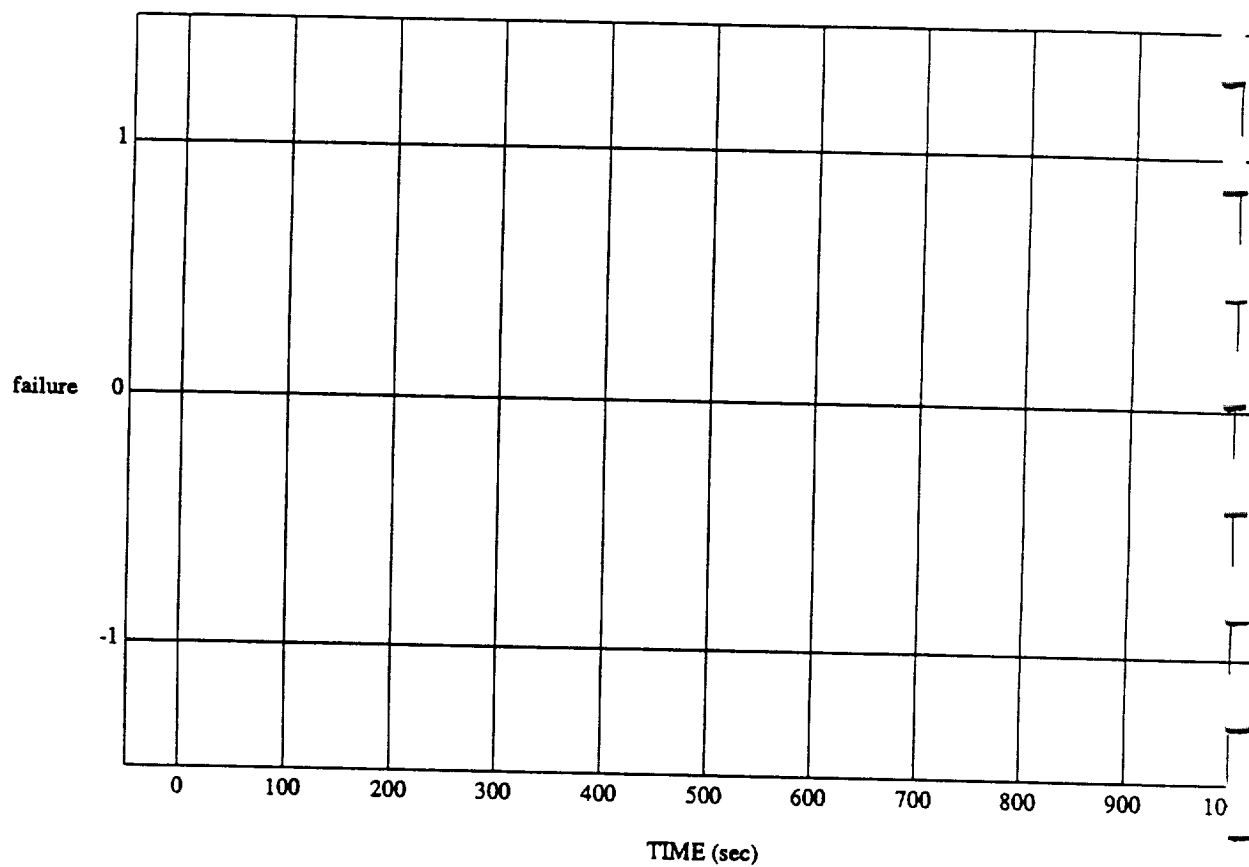


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

failure vs TIME

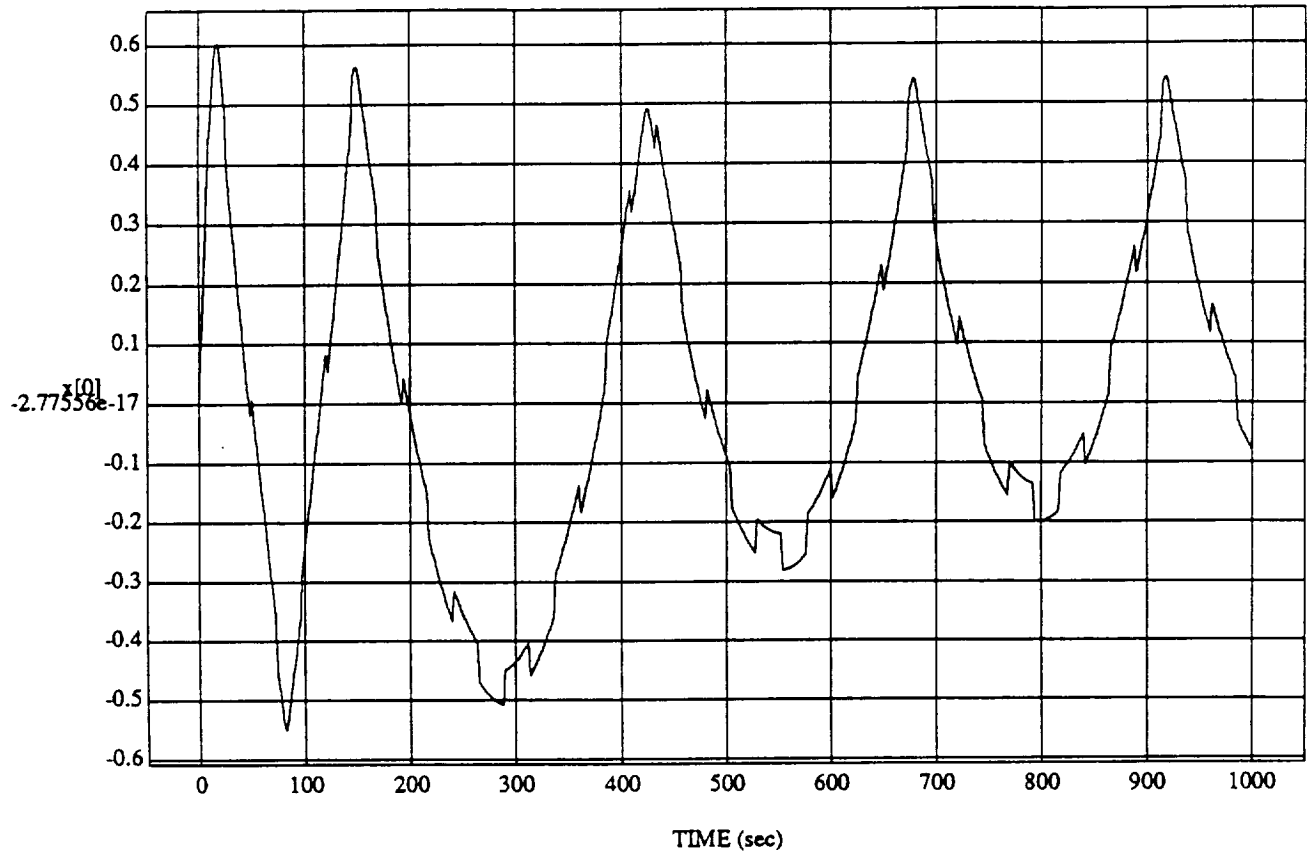
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH1eam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

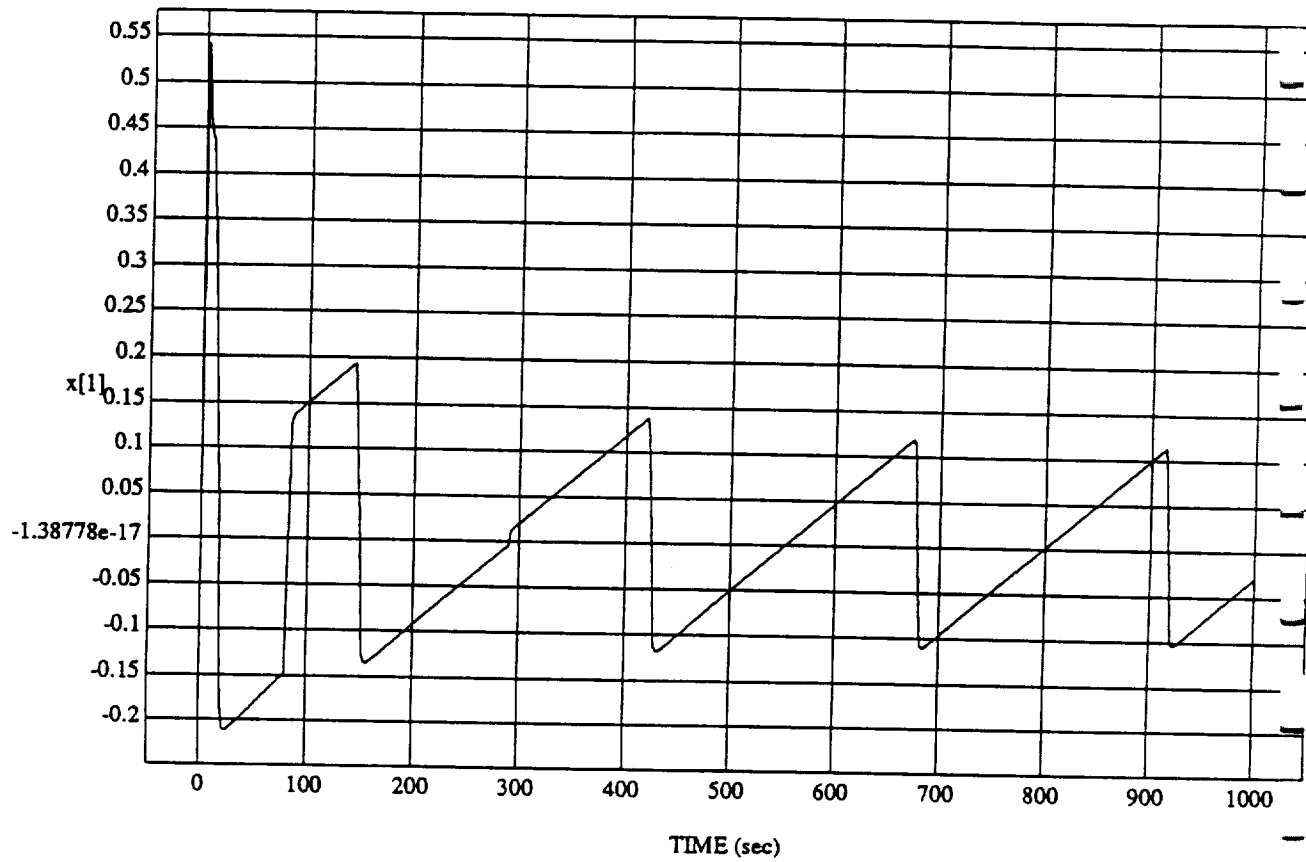
$x[0]$  vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

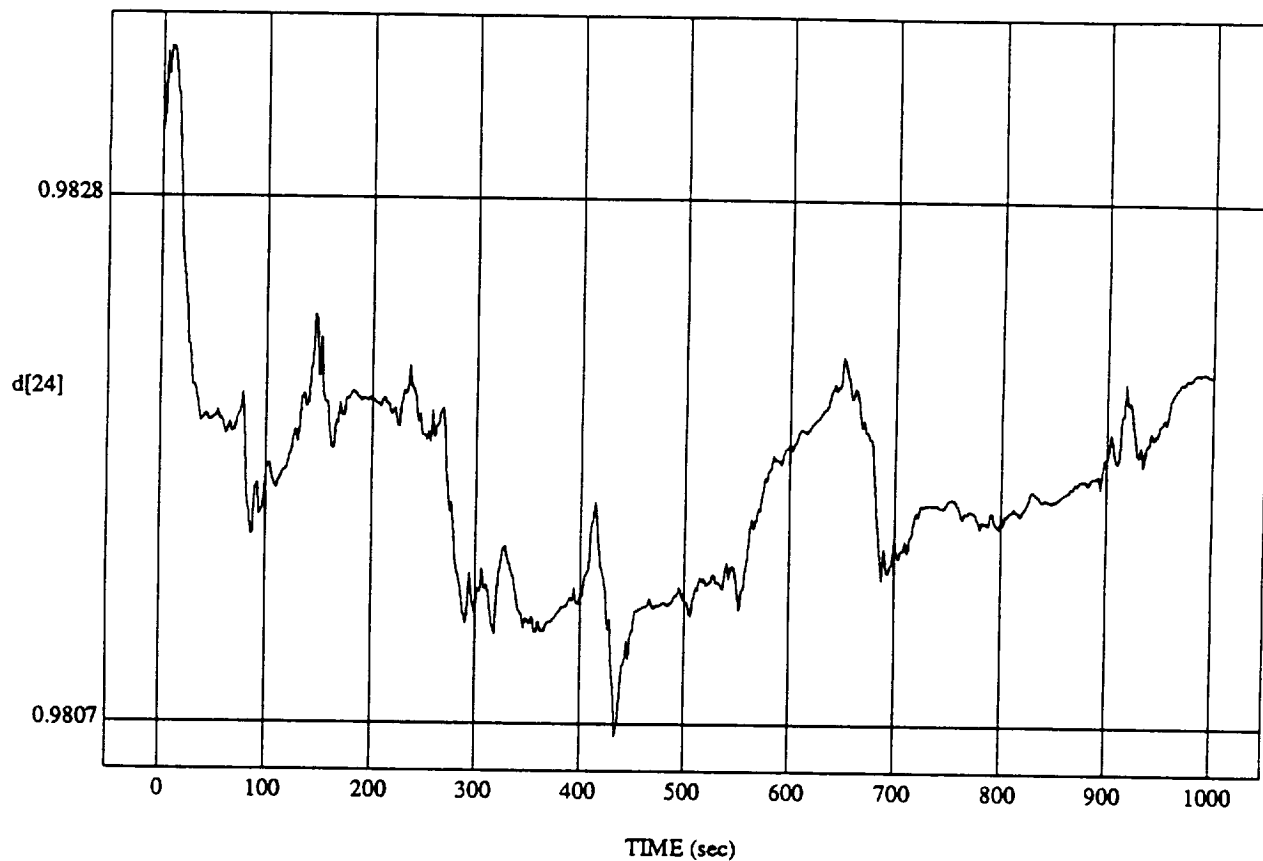
$x[1]$  vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[24] vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992

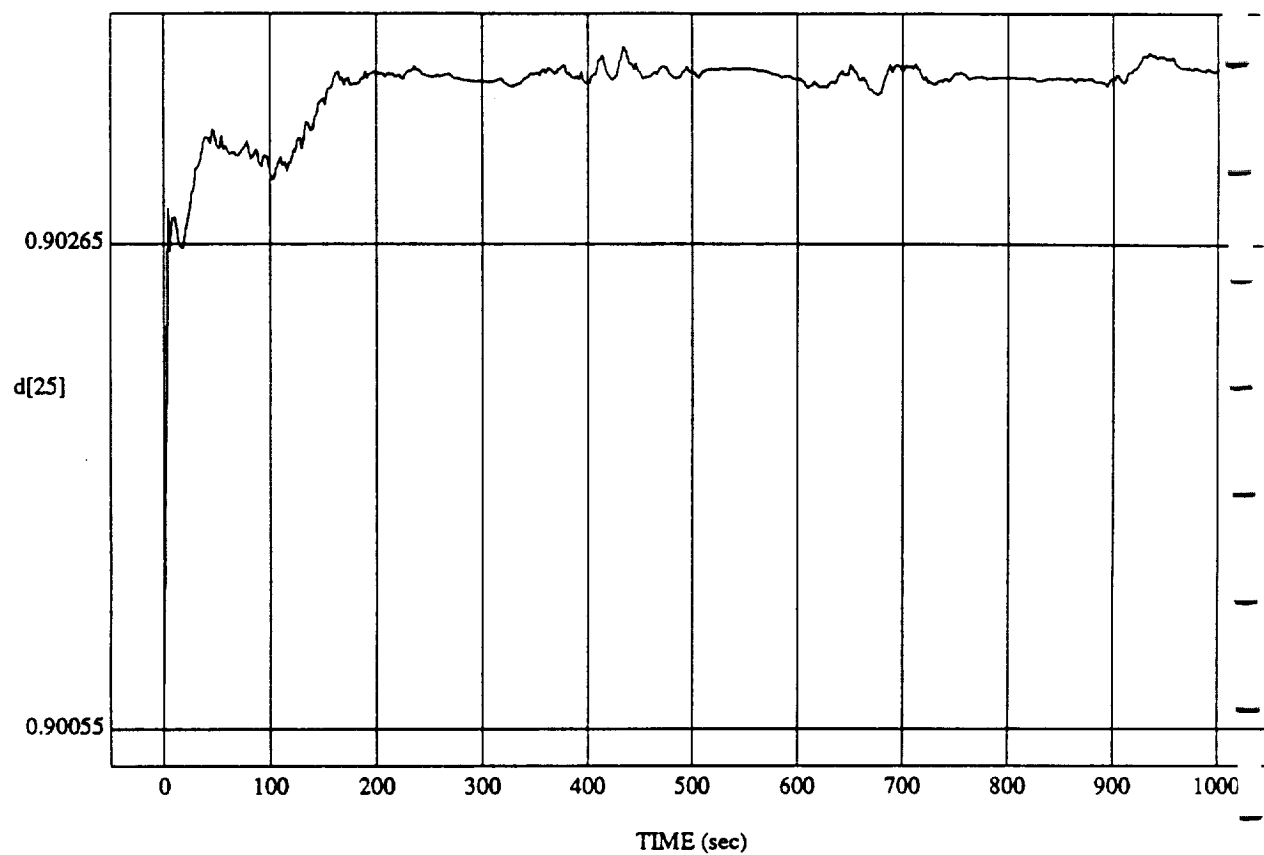


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[25] vs TIME

RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



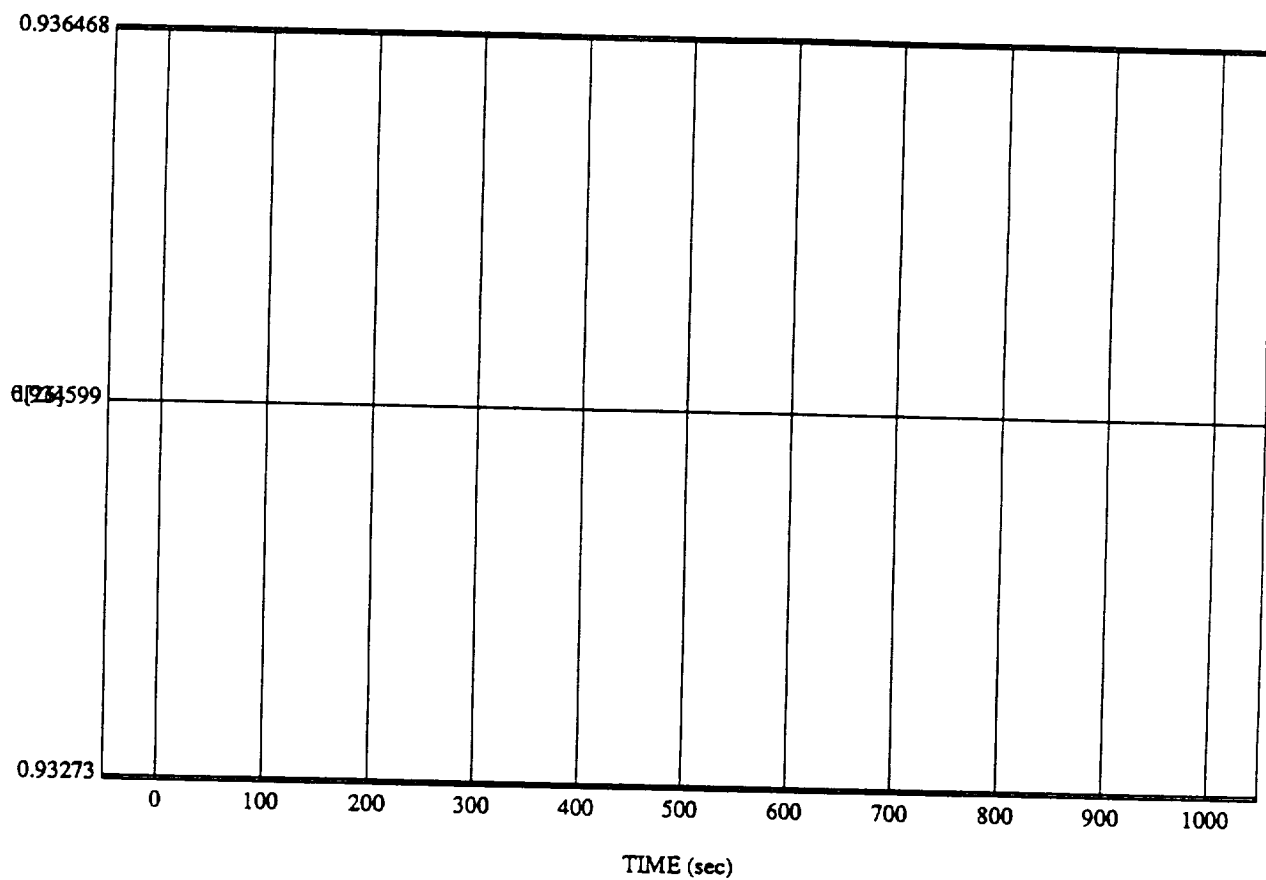
MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[26] vs TIME

RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992

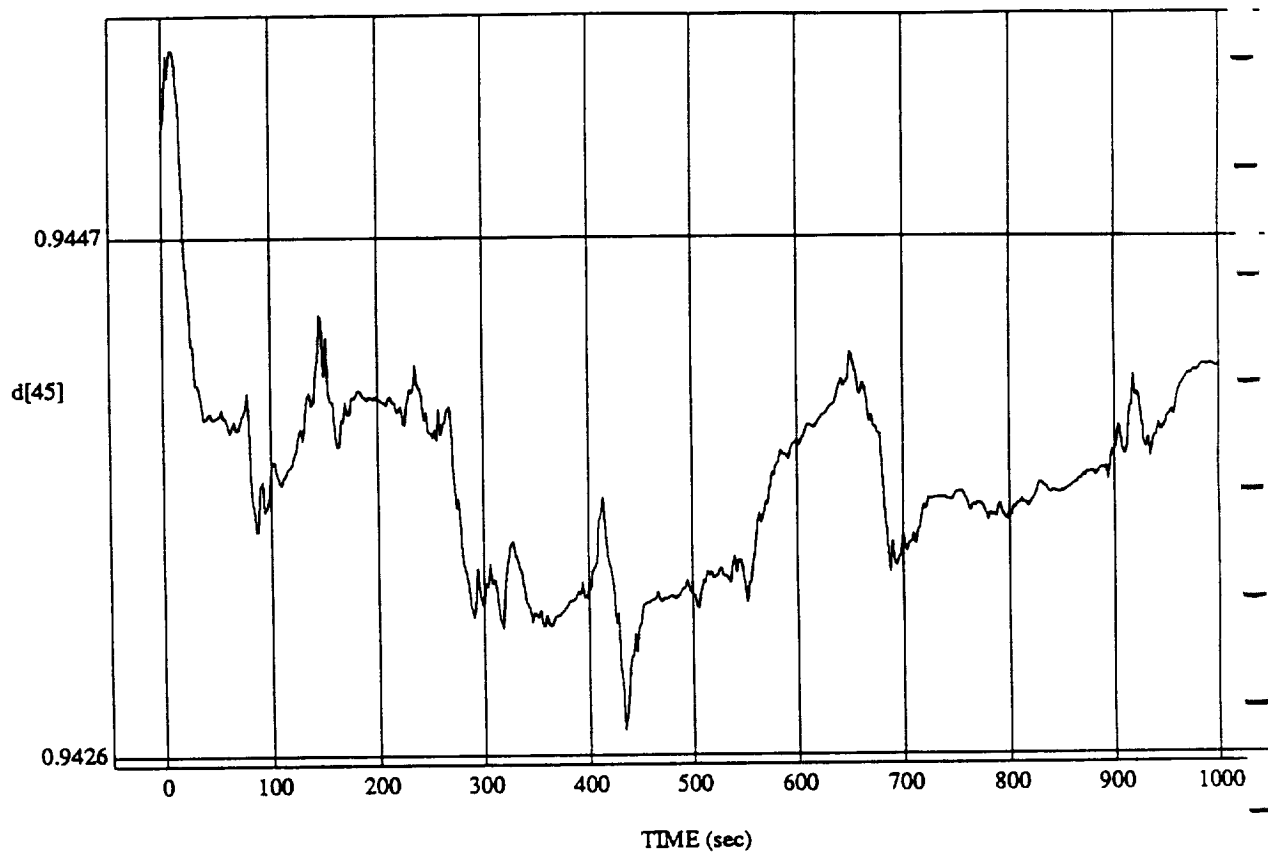


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[45] vs TIME

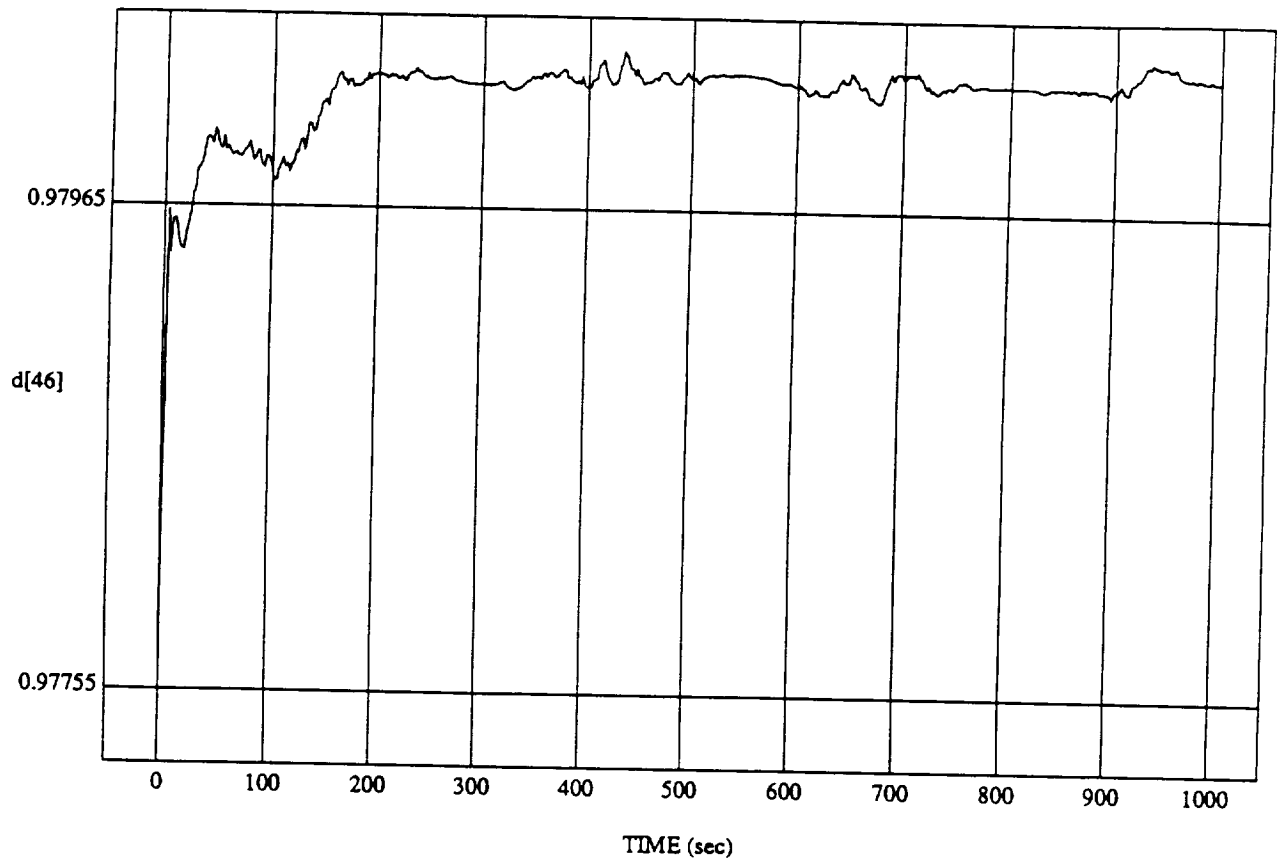
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCHlearn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

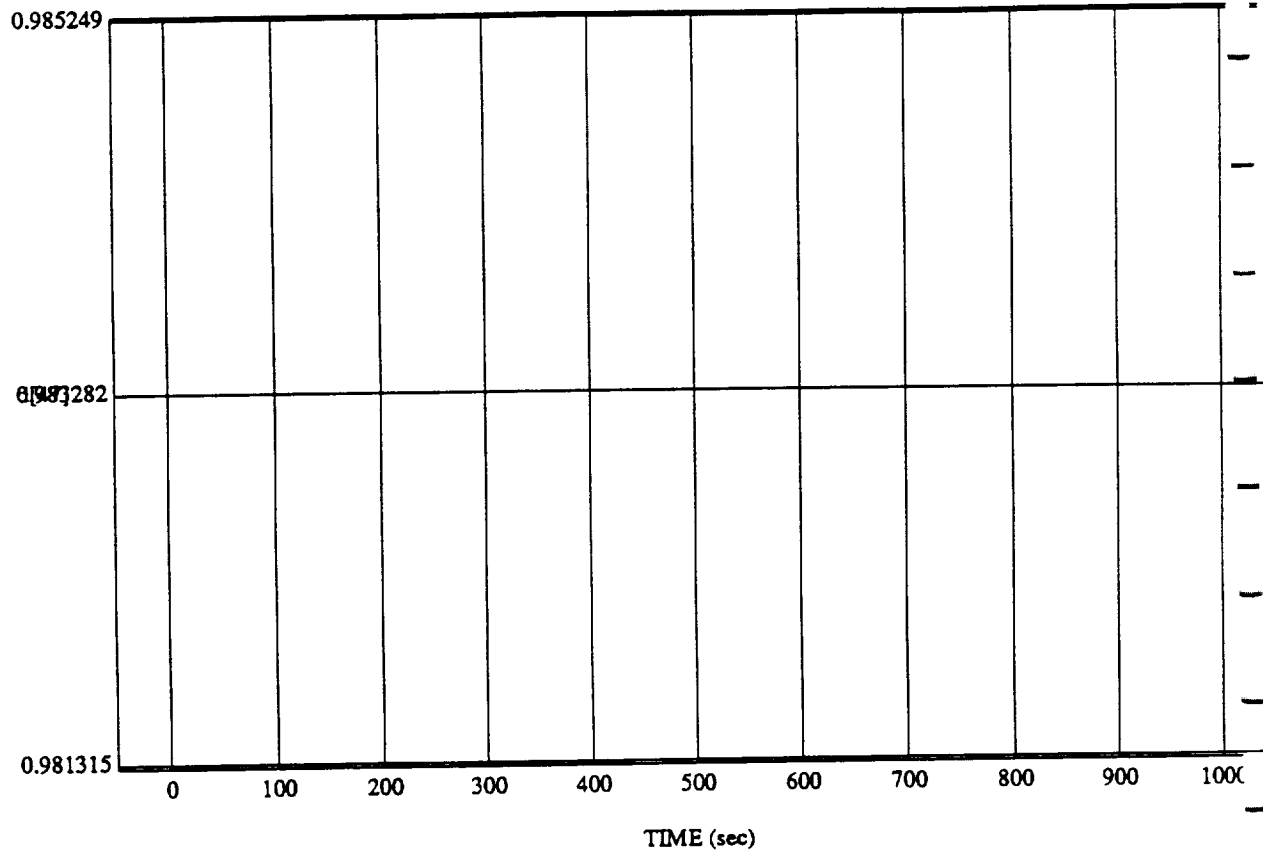
d[46] vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

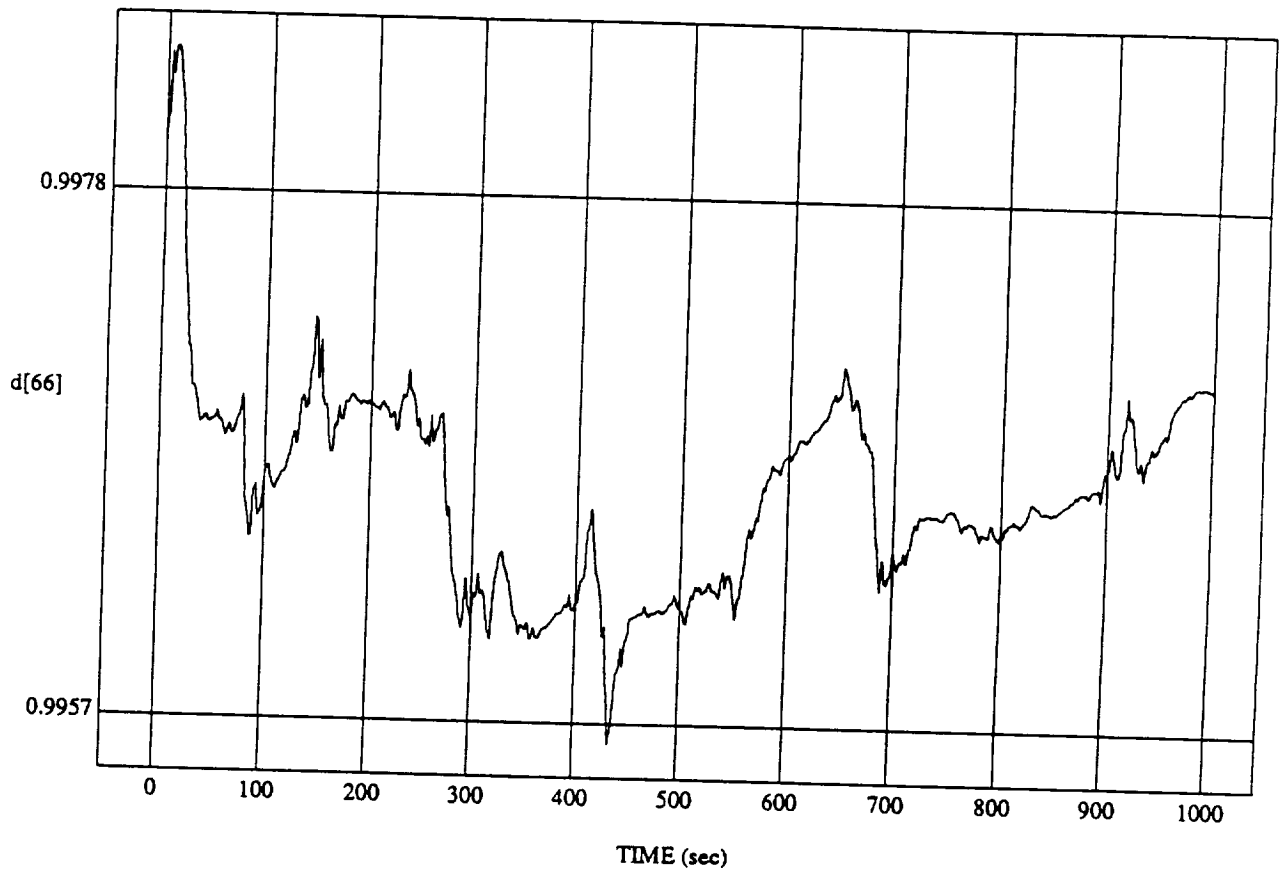
d[47] vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

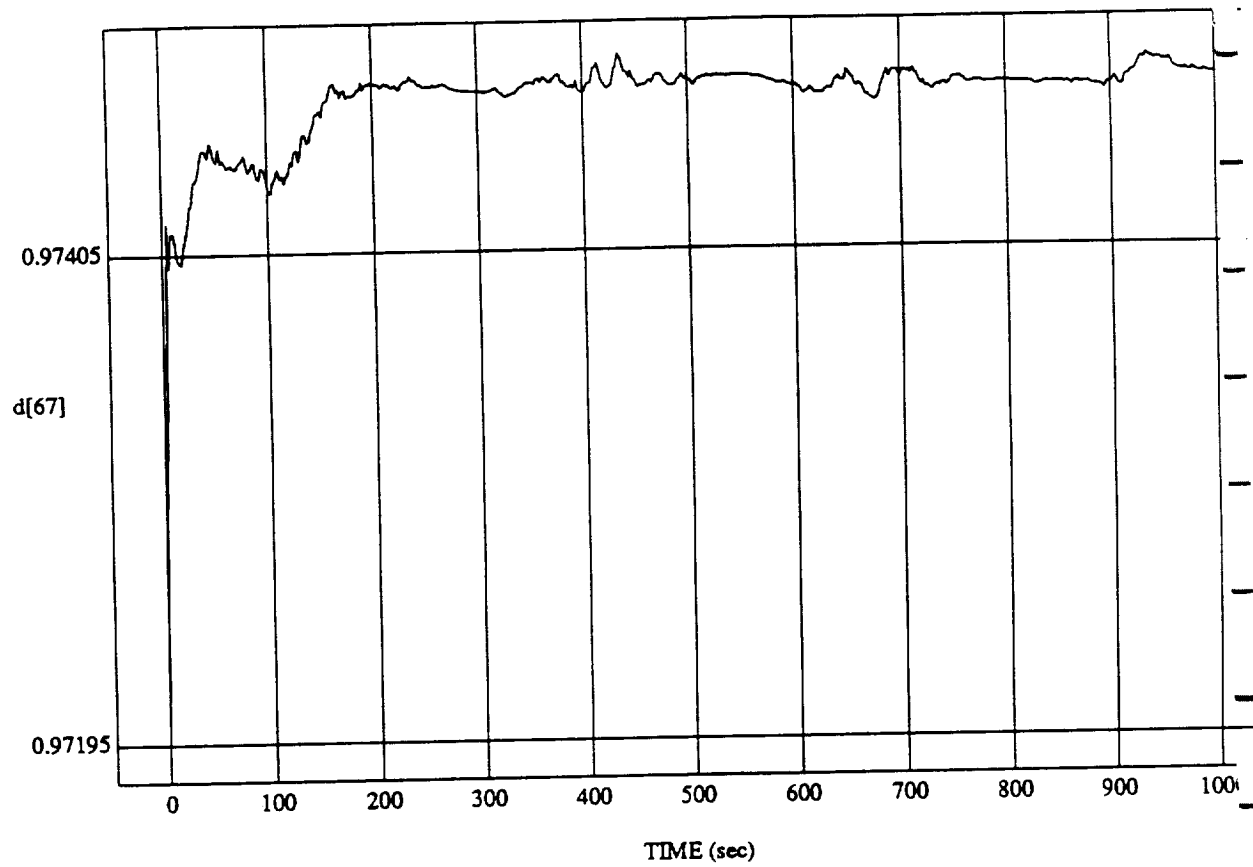
d[66] vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[67] vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992

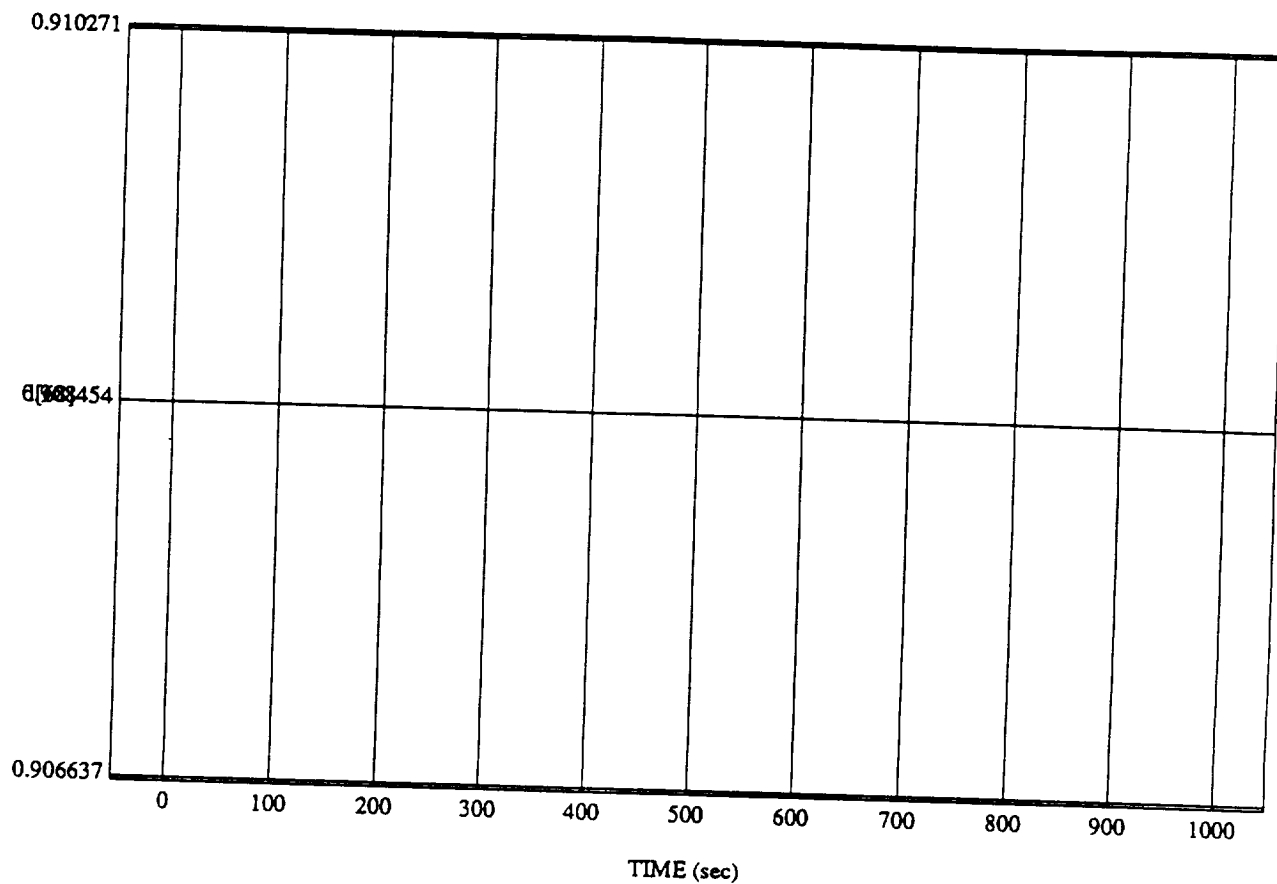


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[68] vs TIME

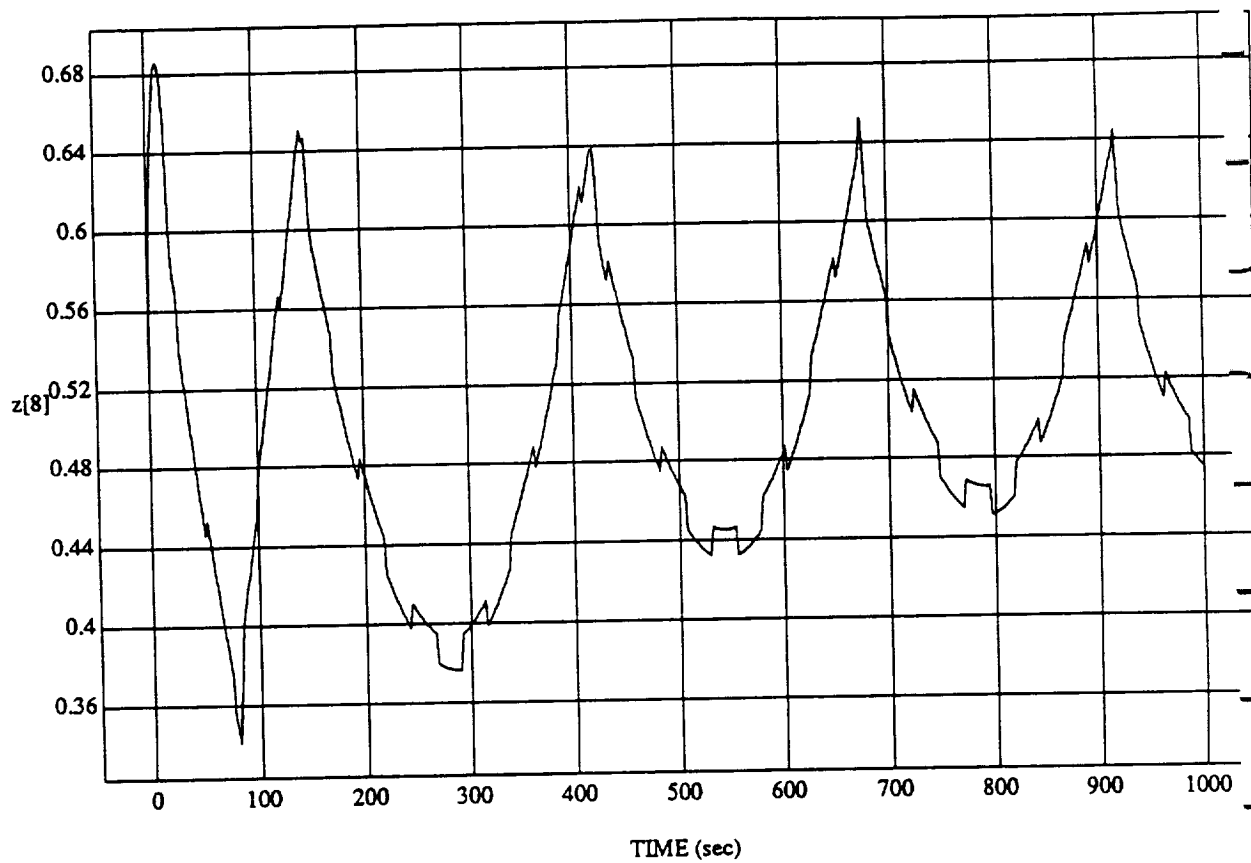
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$z[8]$  vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992

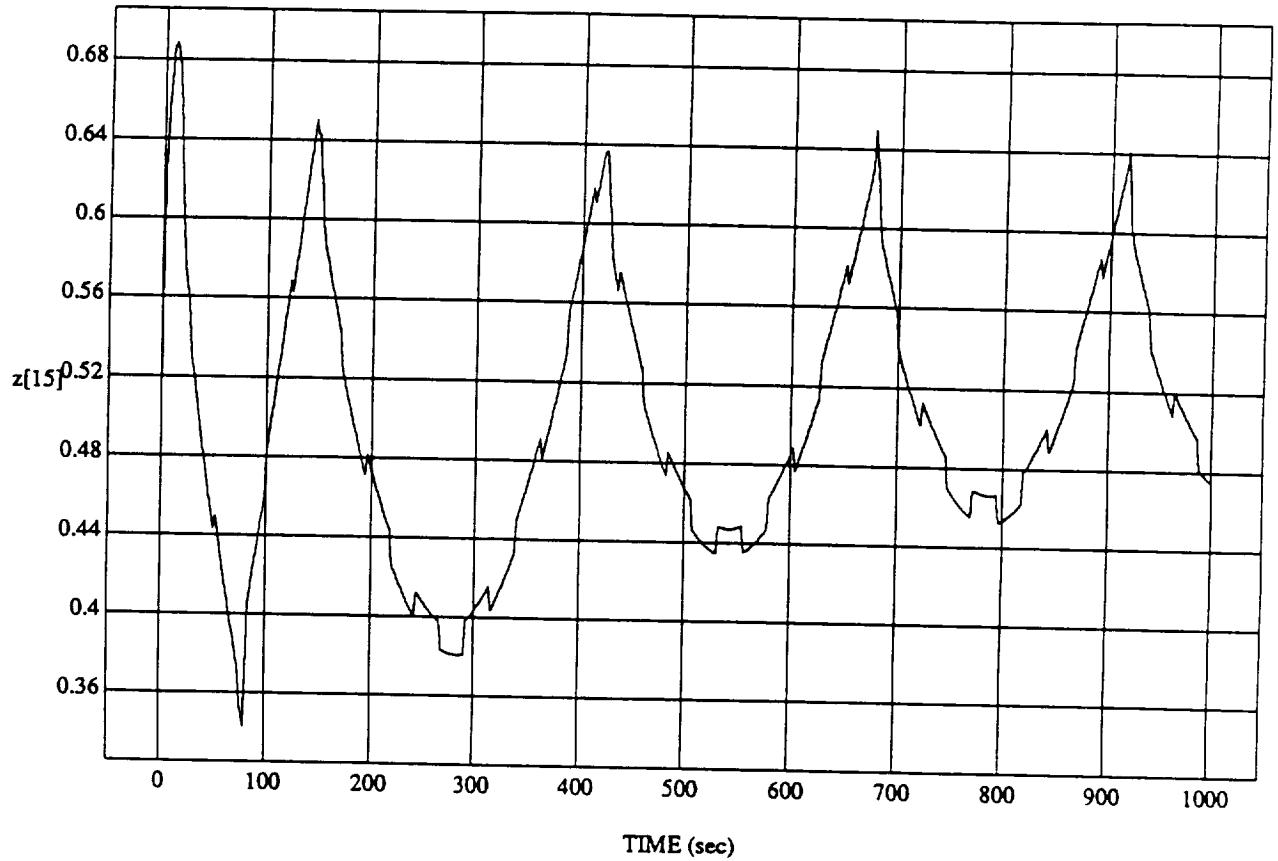


MODULE: ORB\_FUZZ\_BATCH.iam2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

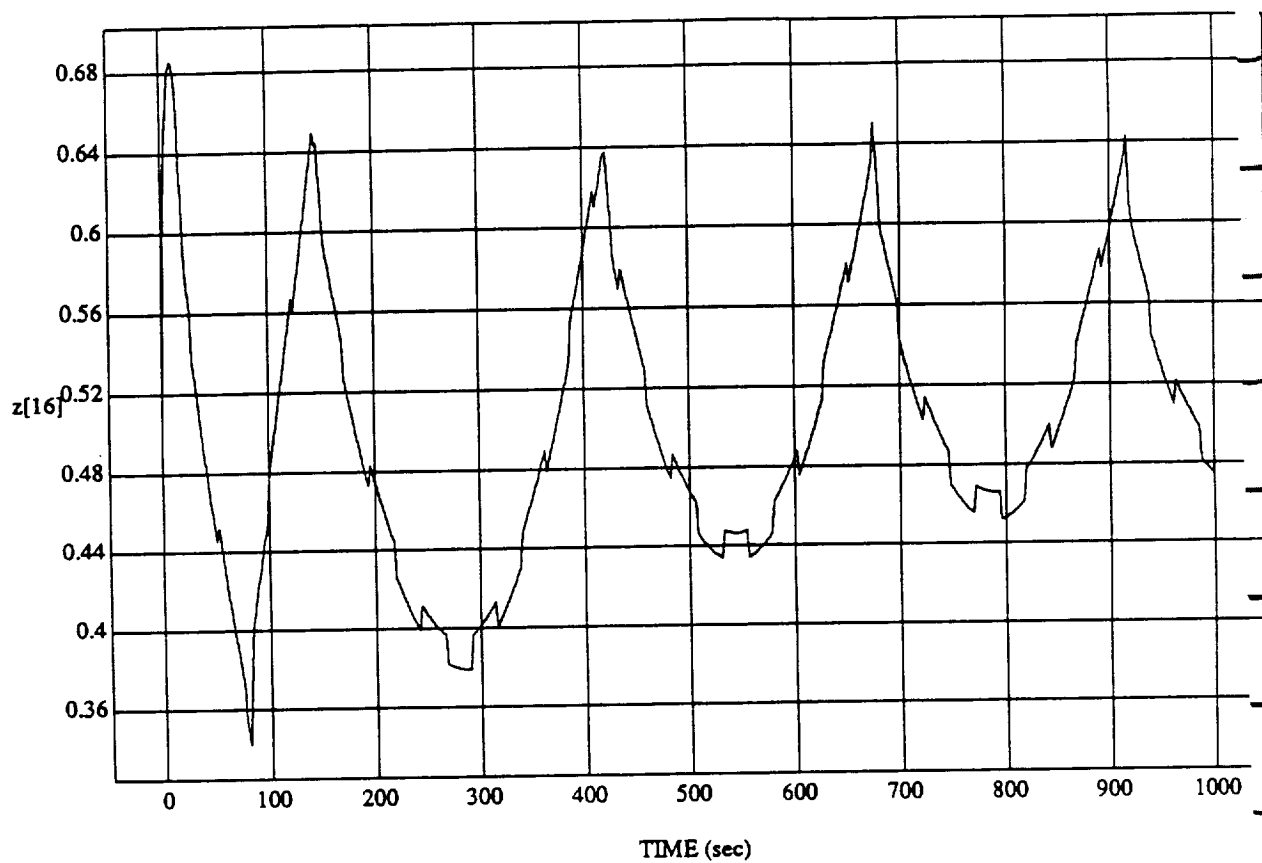
$z[15]$  vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.1cam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

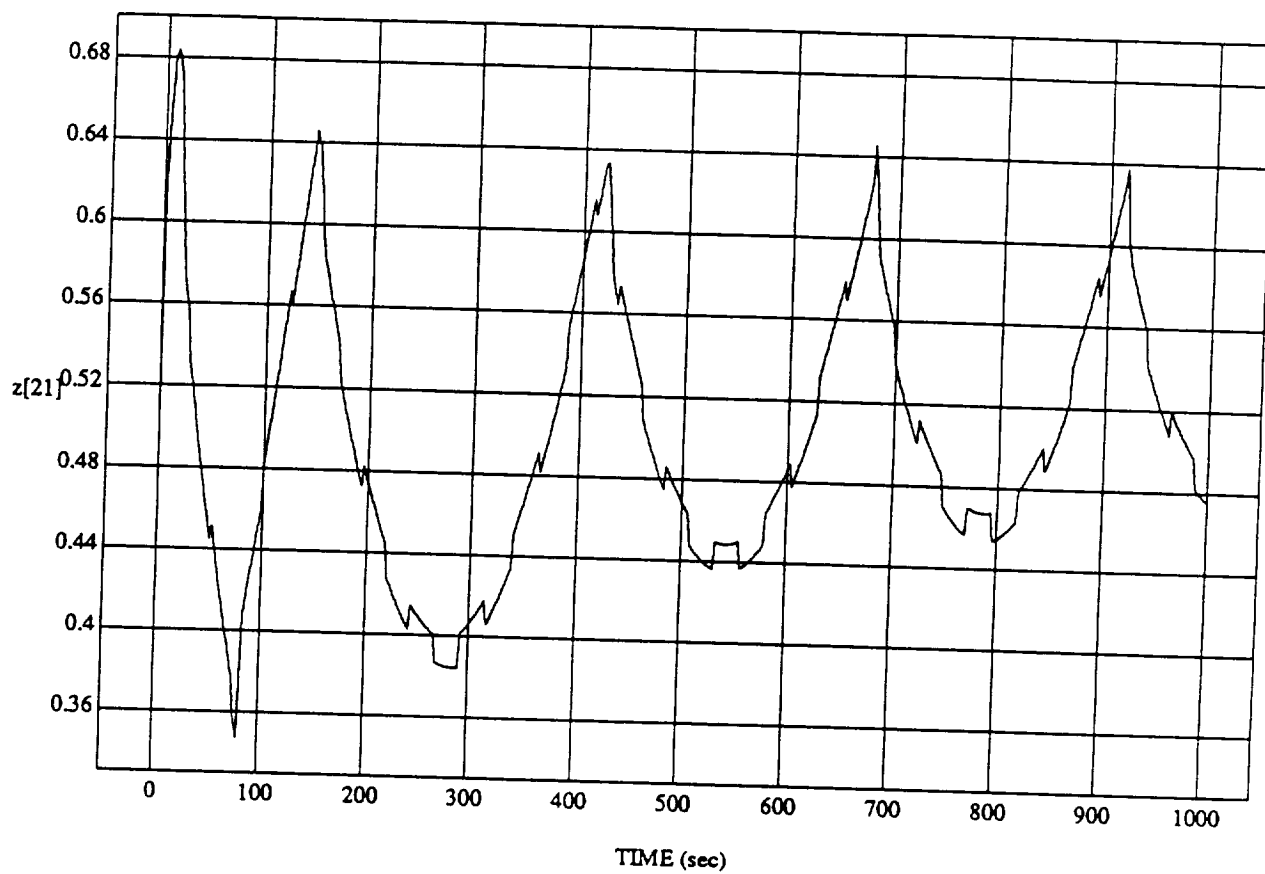
$z[16]$  vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

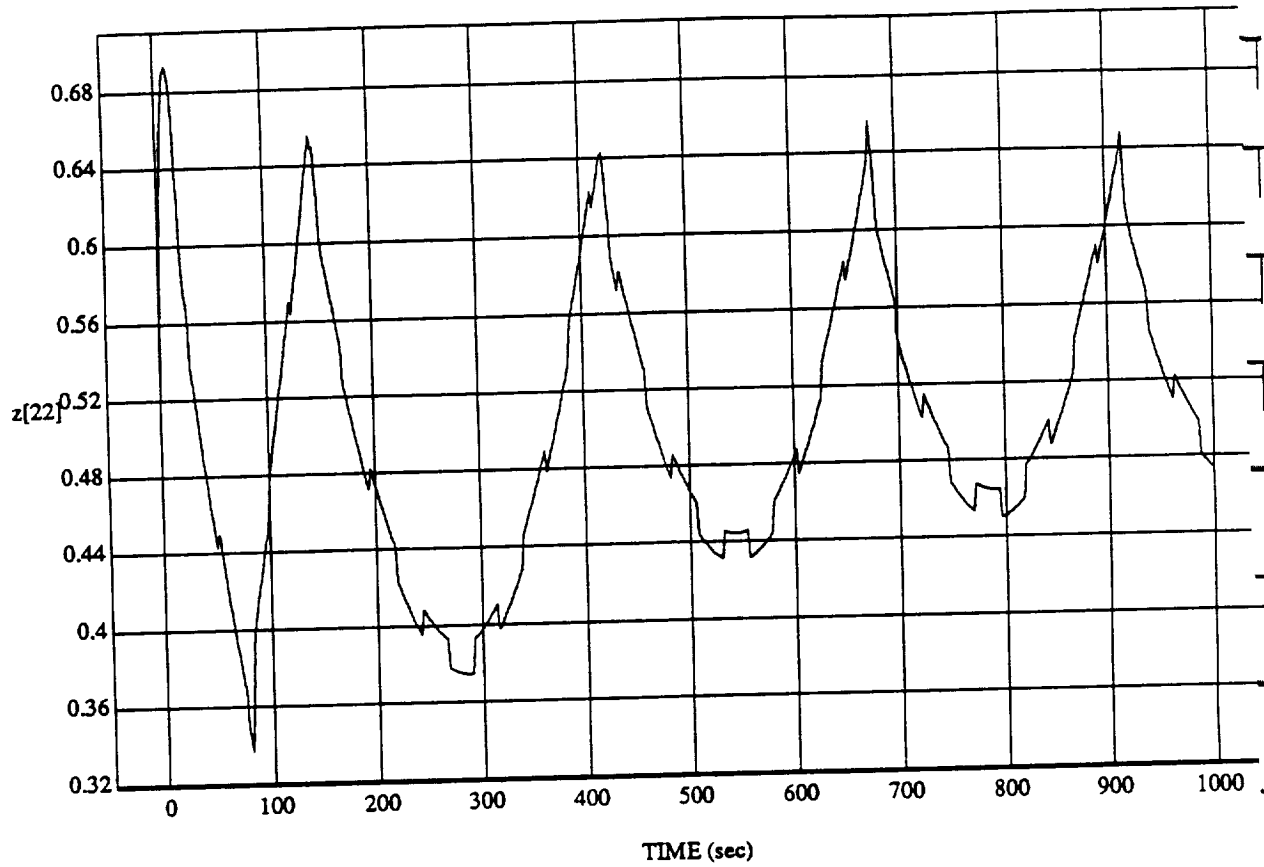
$z[21]$  vs TIME  
RUN: Norm Rules (Only) -  $\rho_h$  At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.1cam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

z[22] vs TIME  
RUN: Norm Rules (Only) - Rho\_h At 0.8 & Bias 0.0 - 1 July 1992



MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.500 Hz



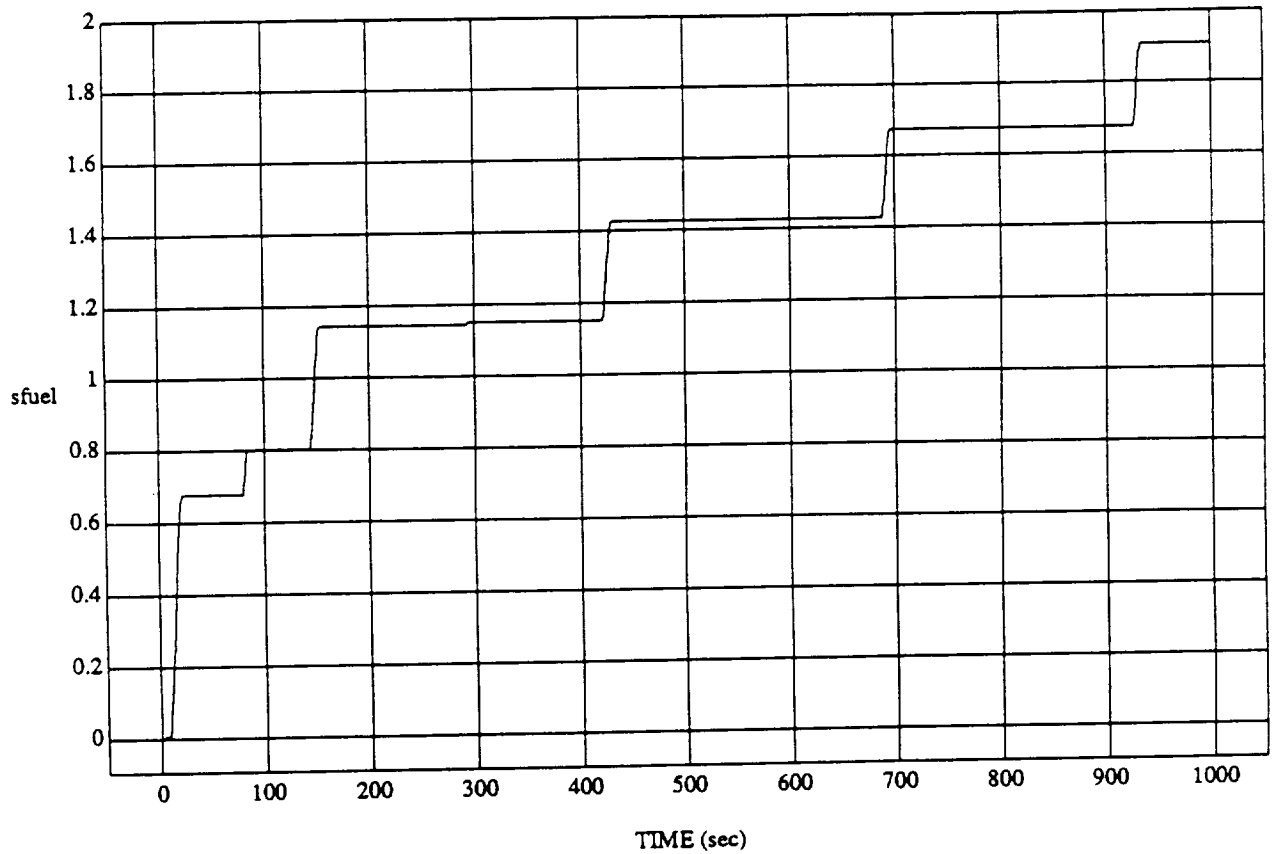


SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

XIII use w.  
on f's

sfuel vs TIME

RUN: Weights Updated By Rule Strength - 2 July 1992



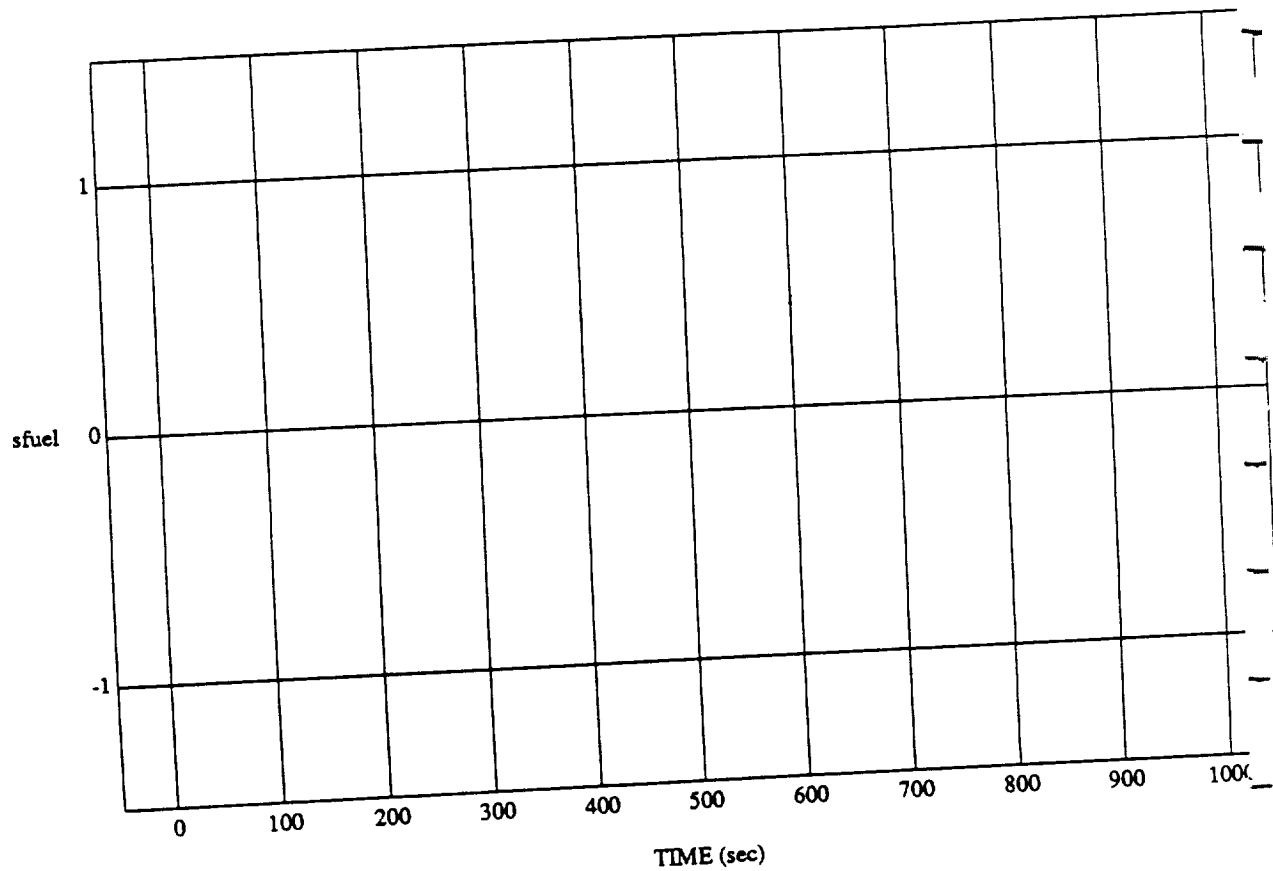
MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.500 Hz

ORBITAL OPERATIONS SIMULATOR

Wed Jul 01 1992 05:09:59 PM

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

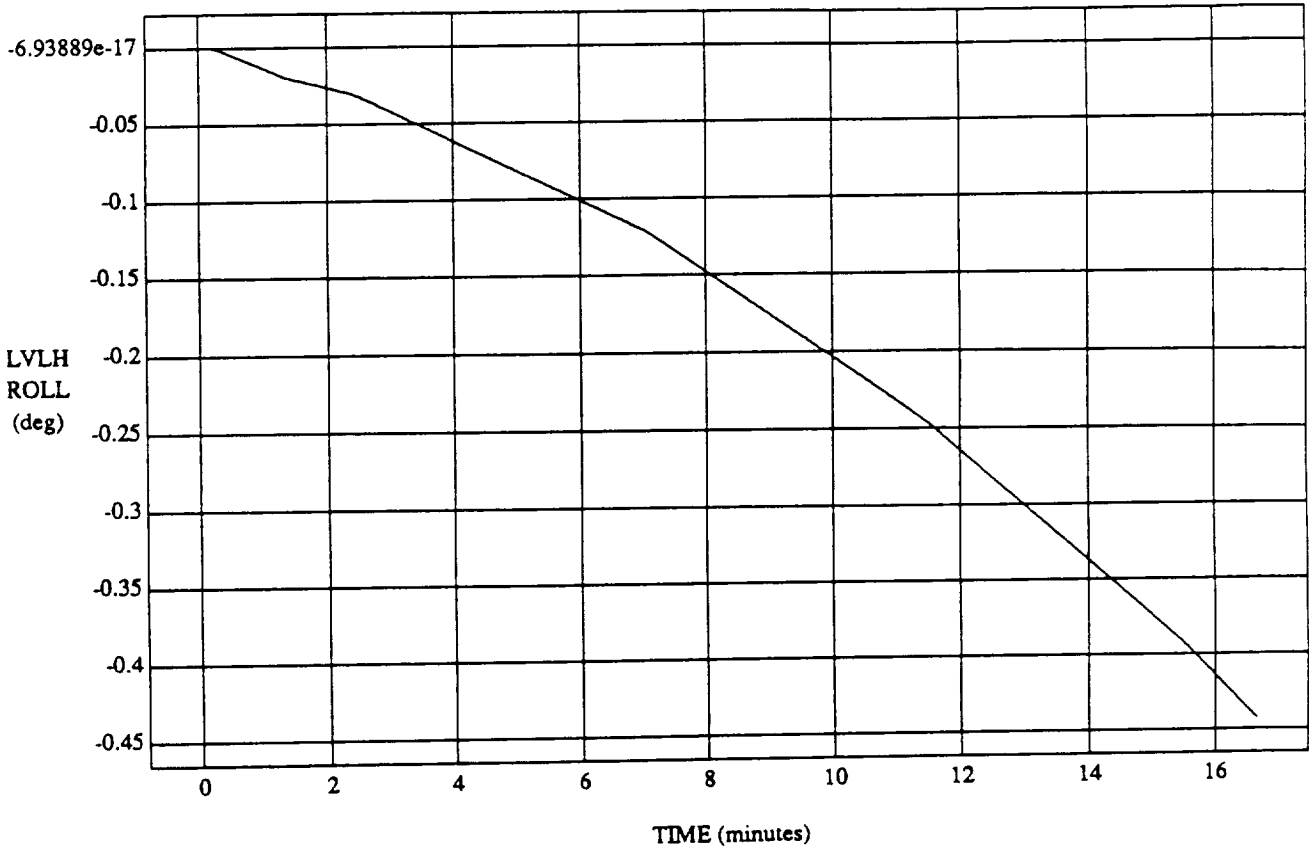


MODULE: ORB\_FUZZ\_BATCH.primary  
DATA SAMPLING FREQUENCY: 0.500 Hz

ORBITAL OPERATIONS SIMULATOR



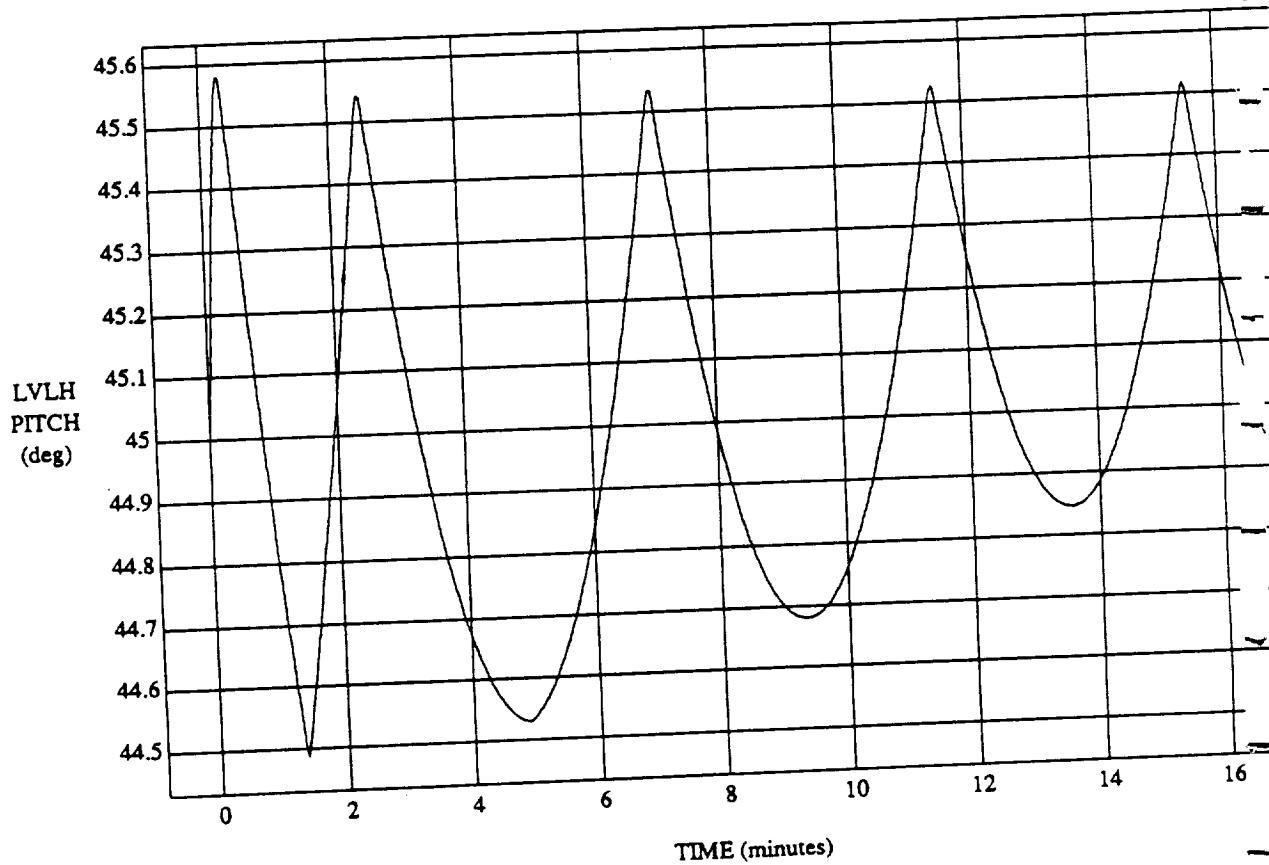
LVLH EULER PYR ROLL vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

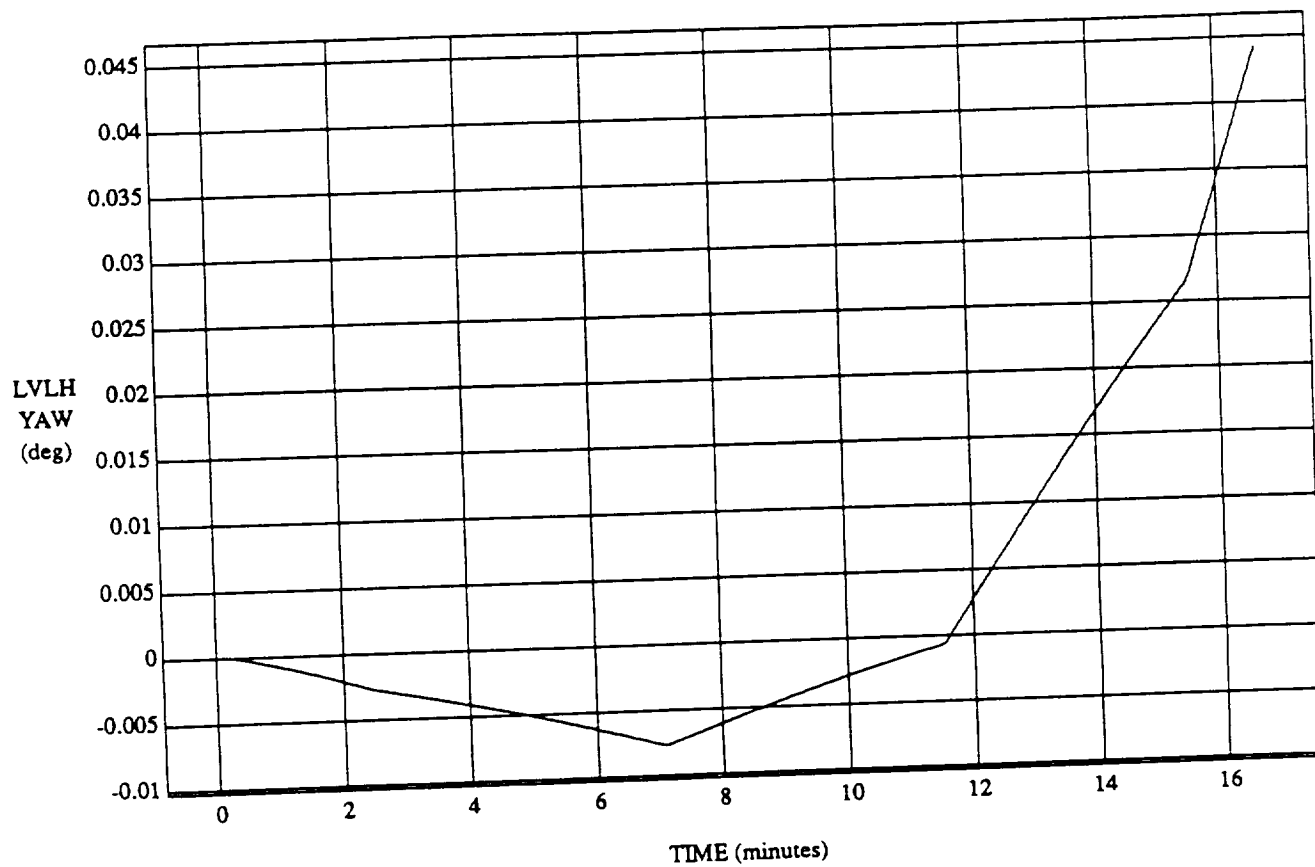
LVLH EULER PYR PITCH vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

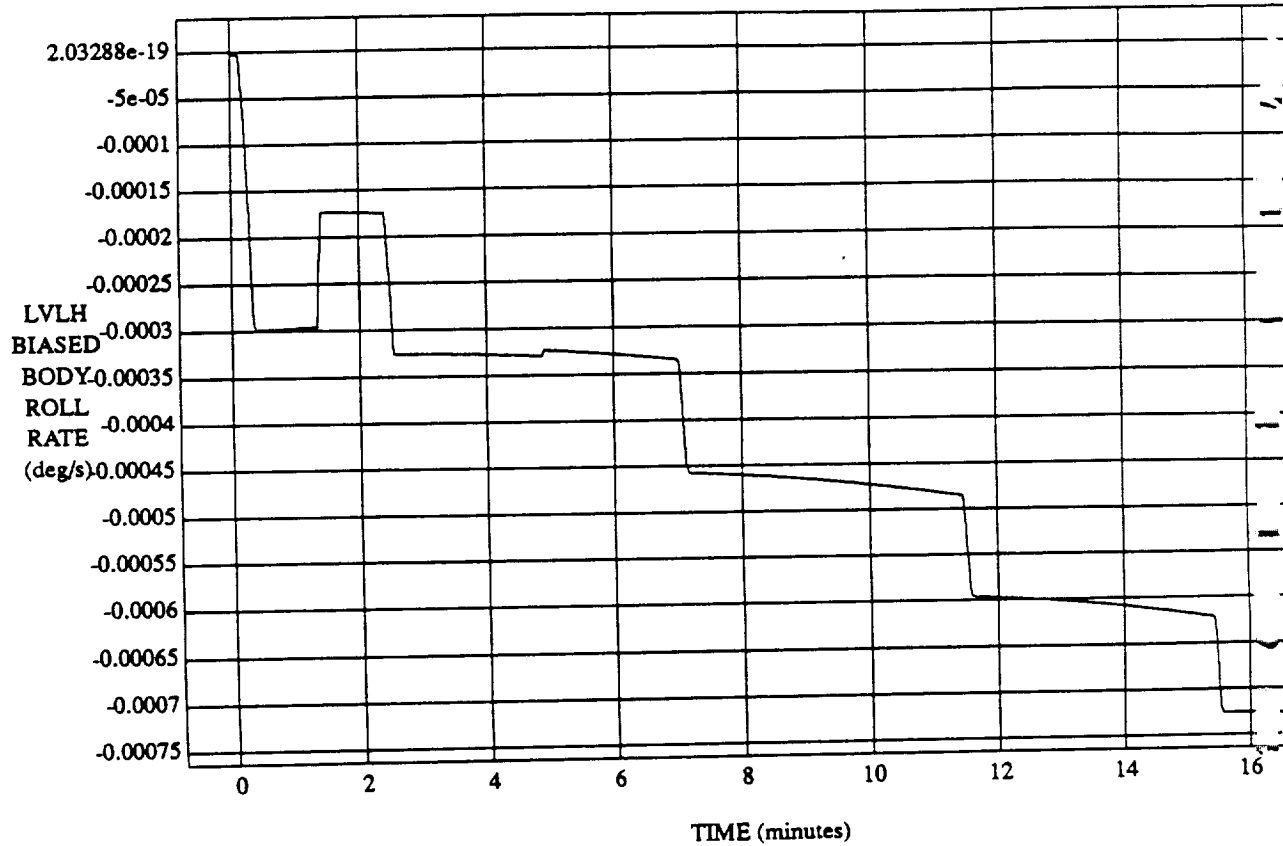
LVLH EULER PYR YAW vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

# LVLH BIASED BODY ROLL RATE vs TIME

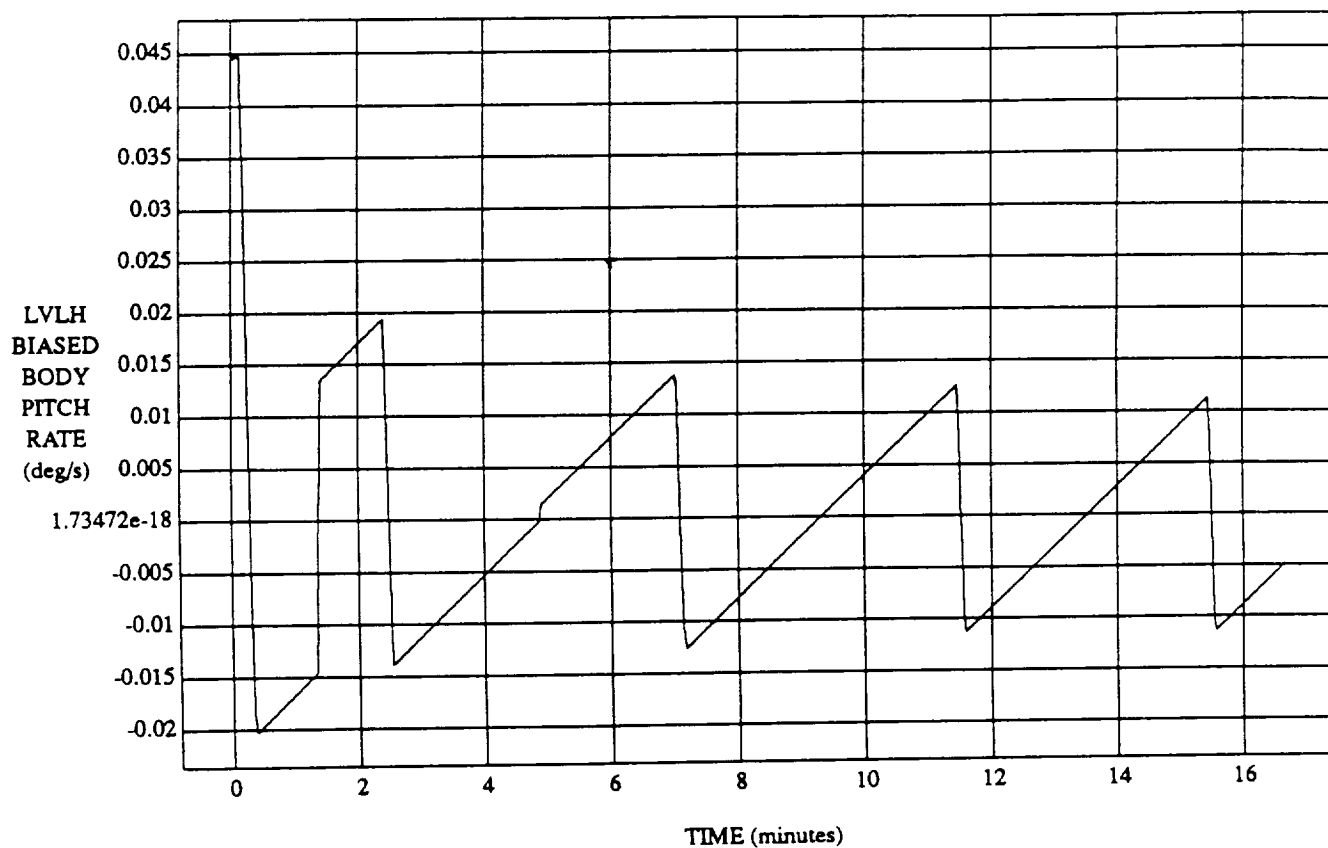
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

### LVLH BIASED BODY PITCH RATE vs TIME

RUN: Weights Updated By Rule Strength - 2 July 1992

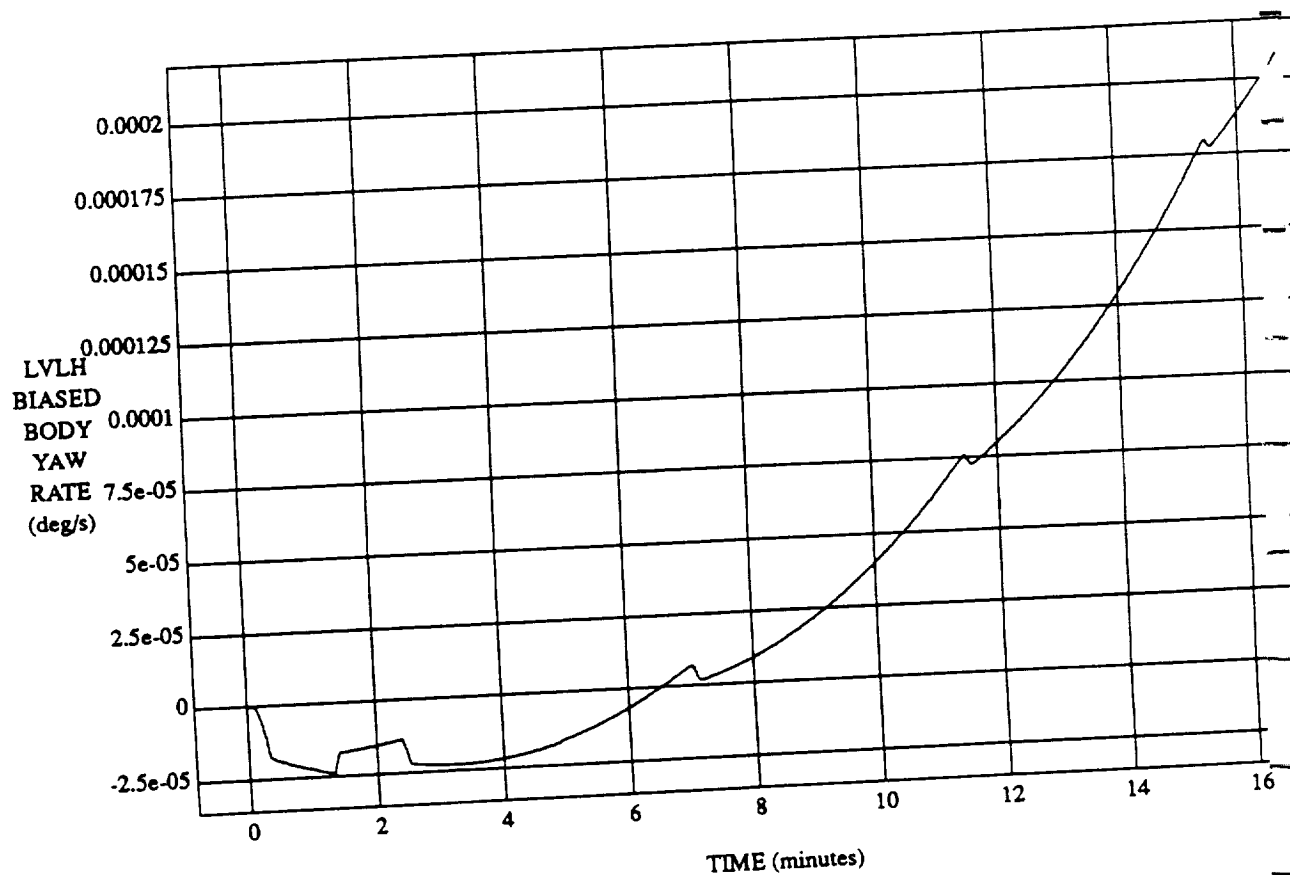


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

# LVLH BIASED BODY YAW RATE vs TIME

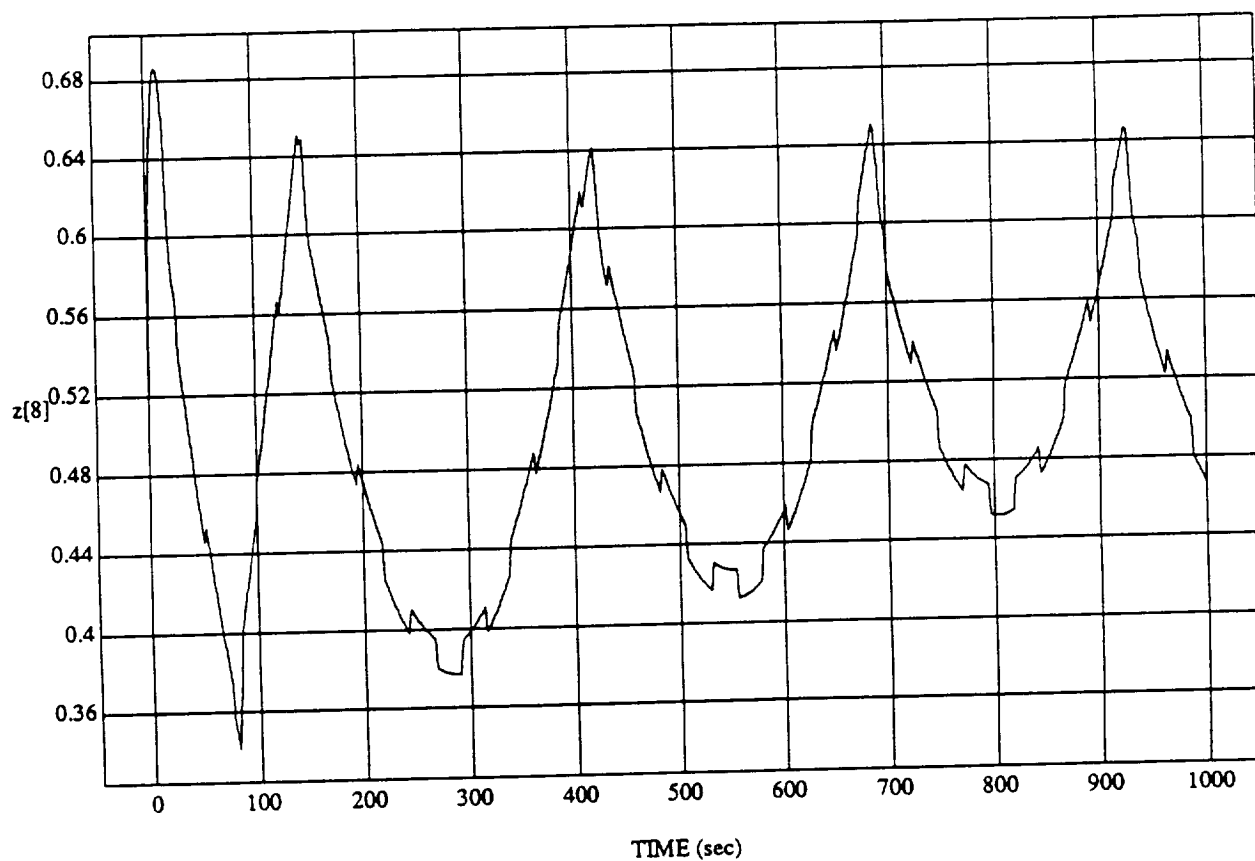
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

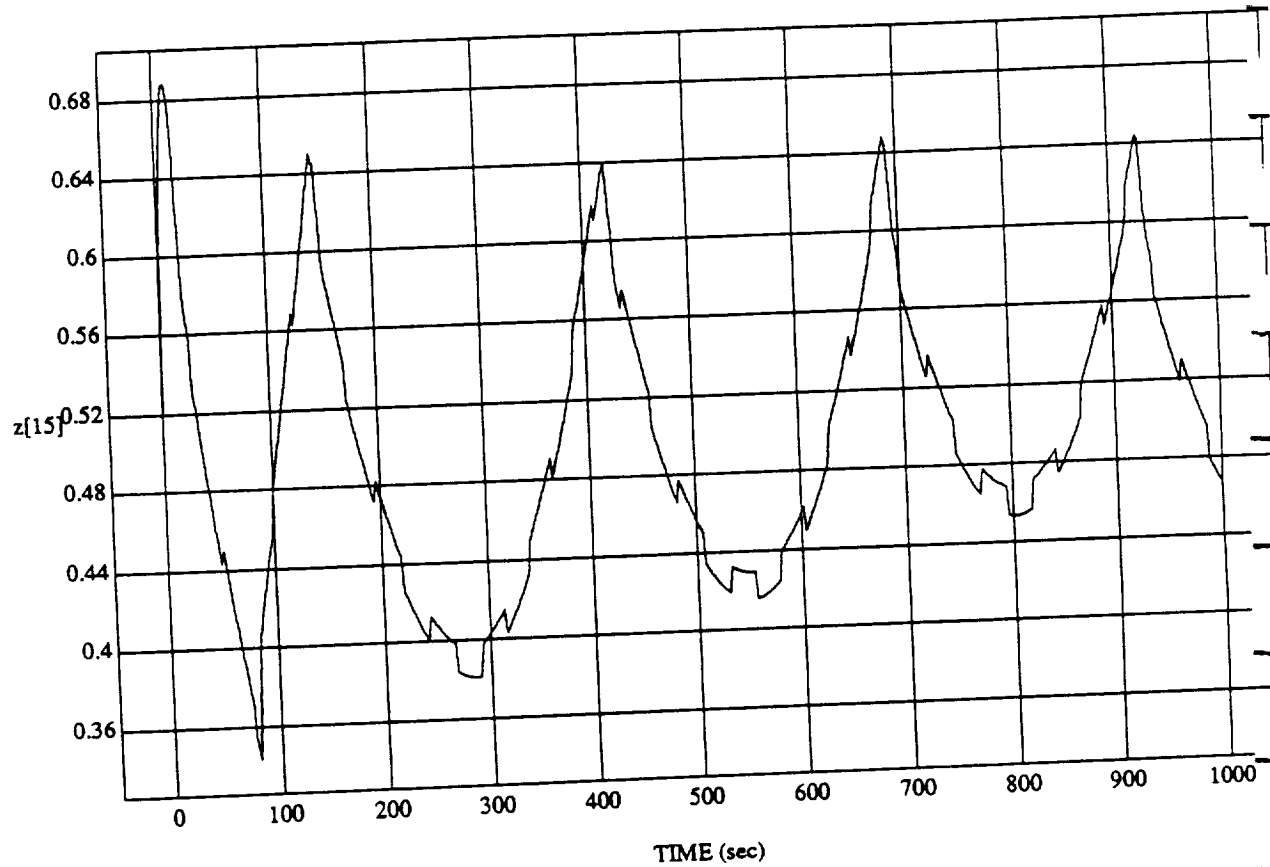
$z[8]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$z[15]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

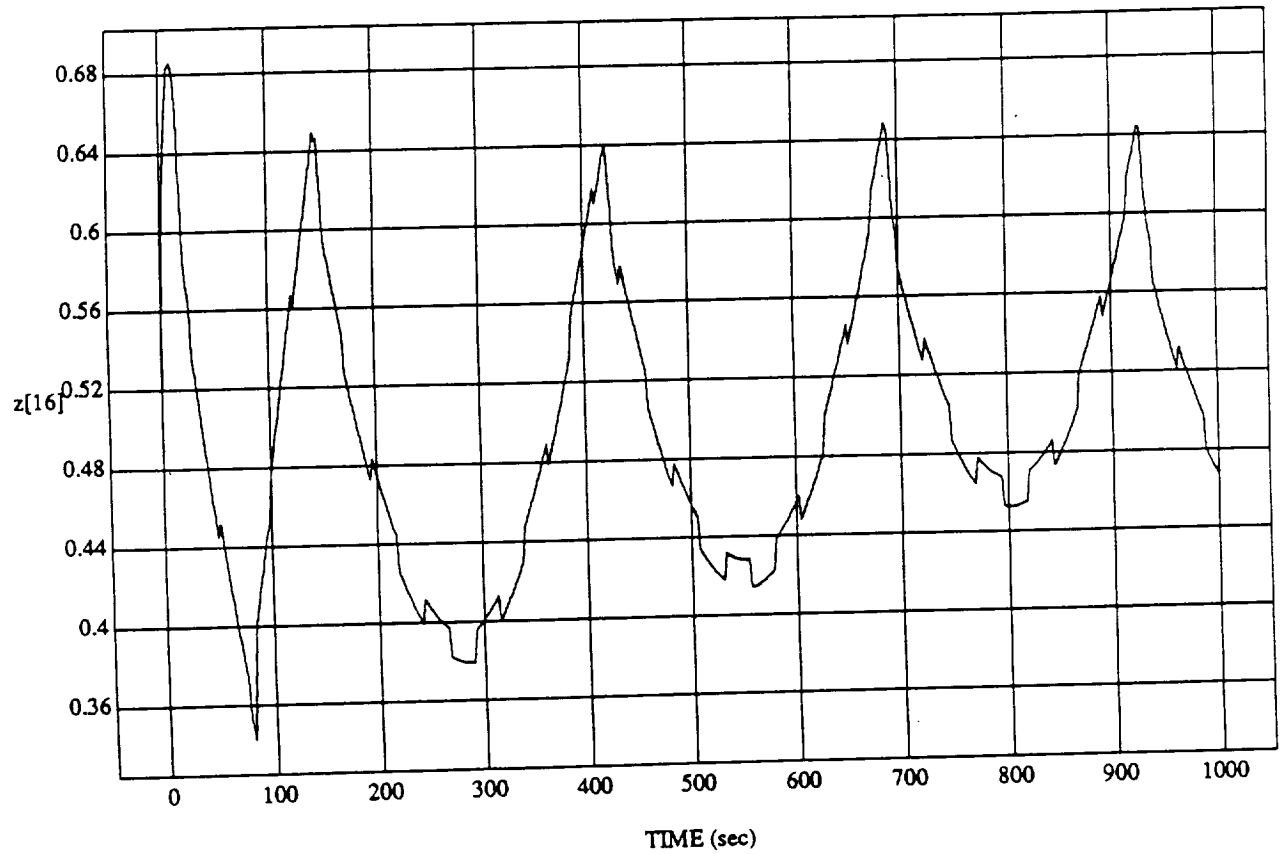


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

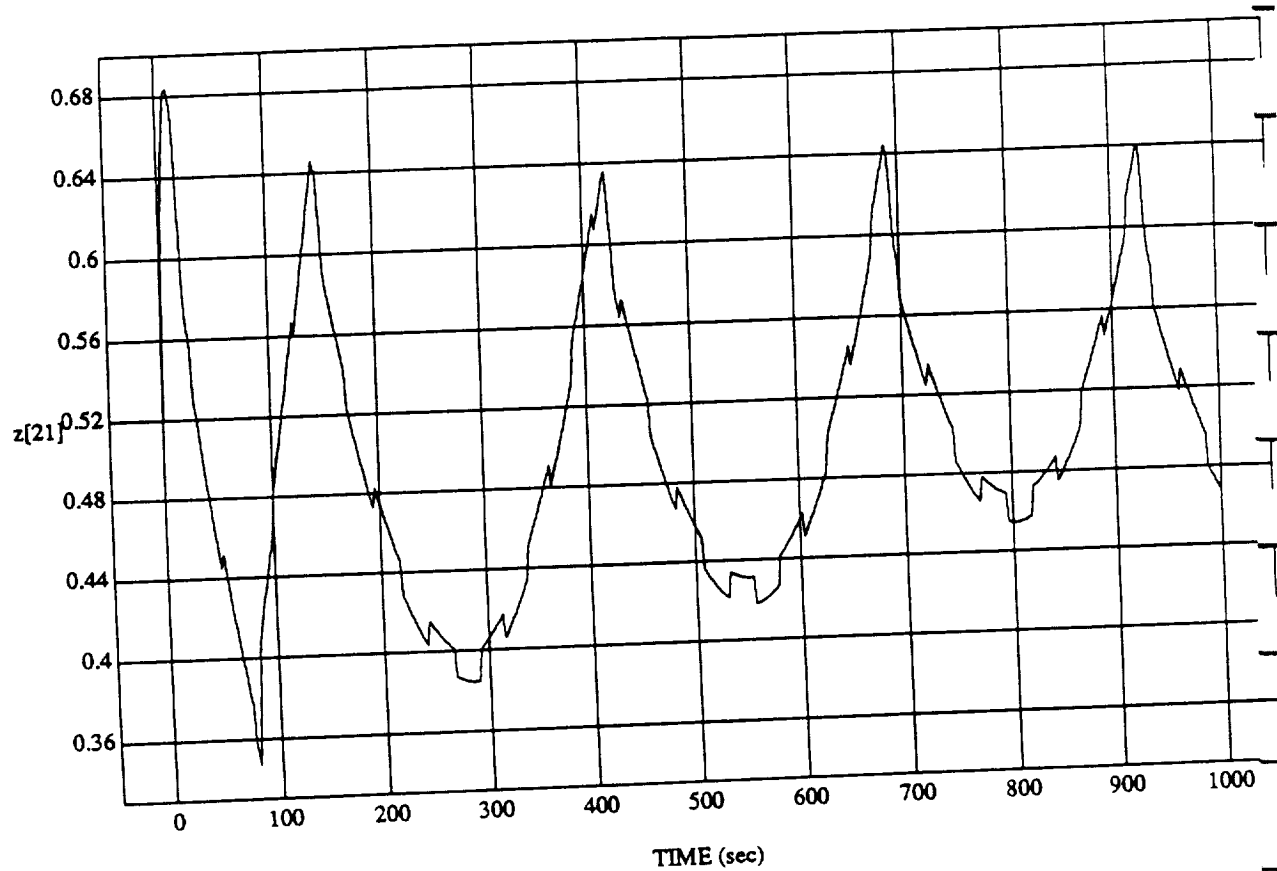
$z[16]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

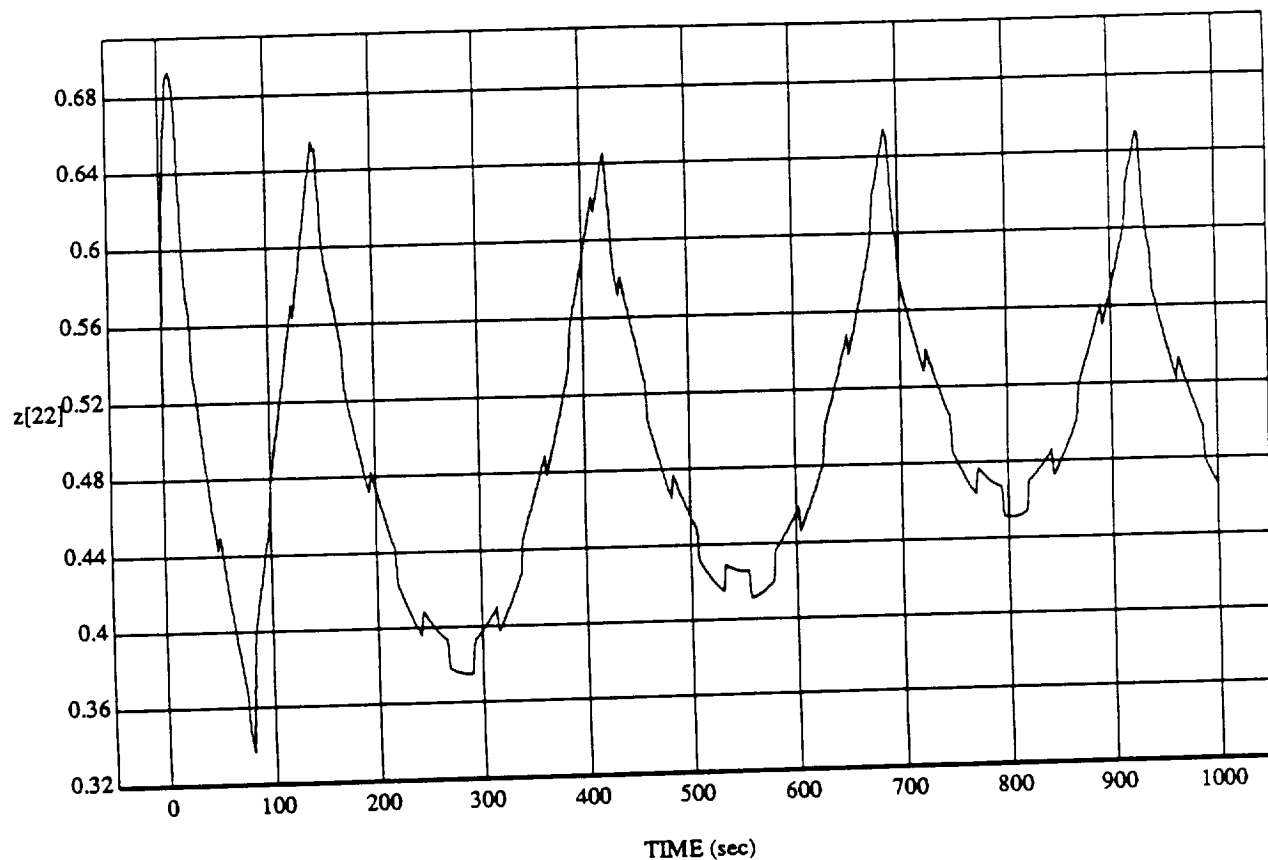
$z[21]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

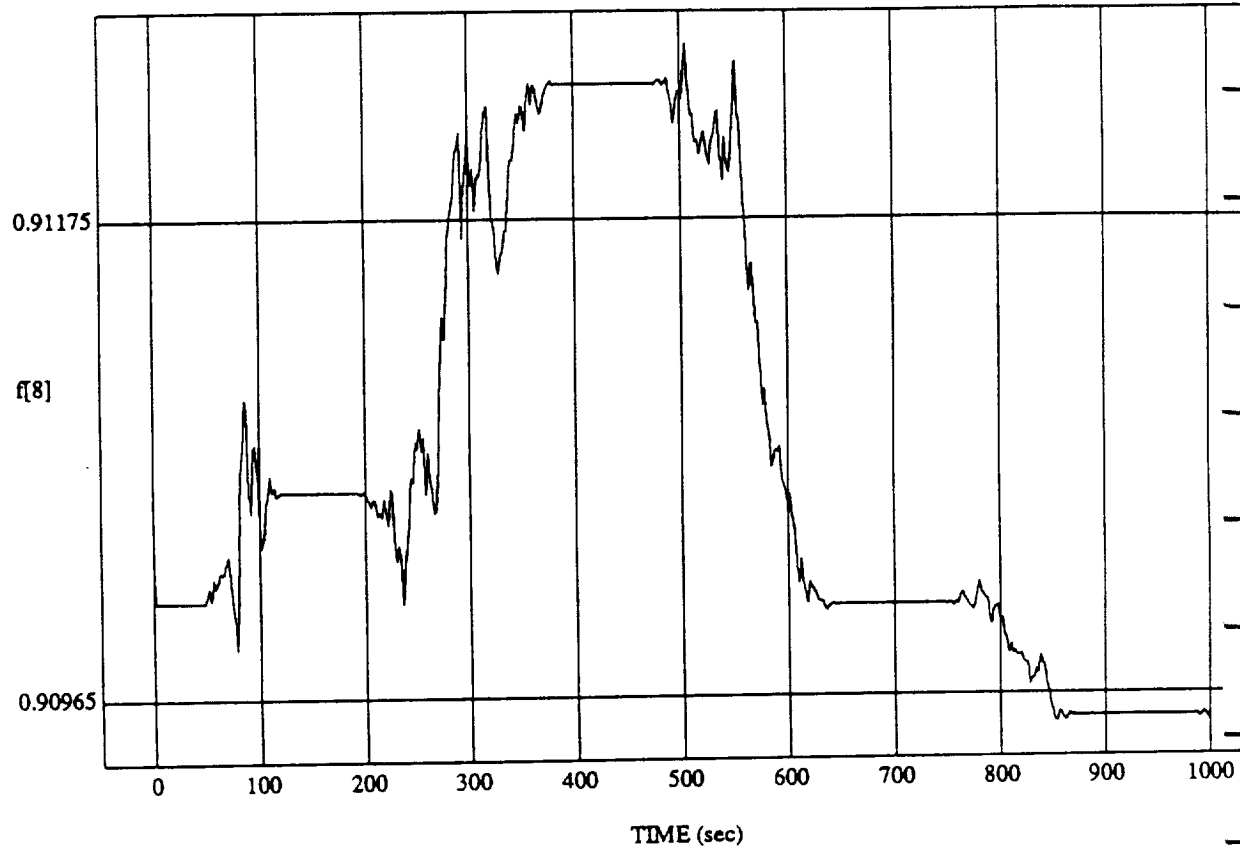
$z[22]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

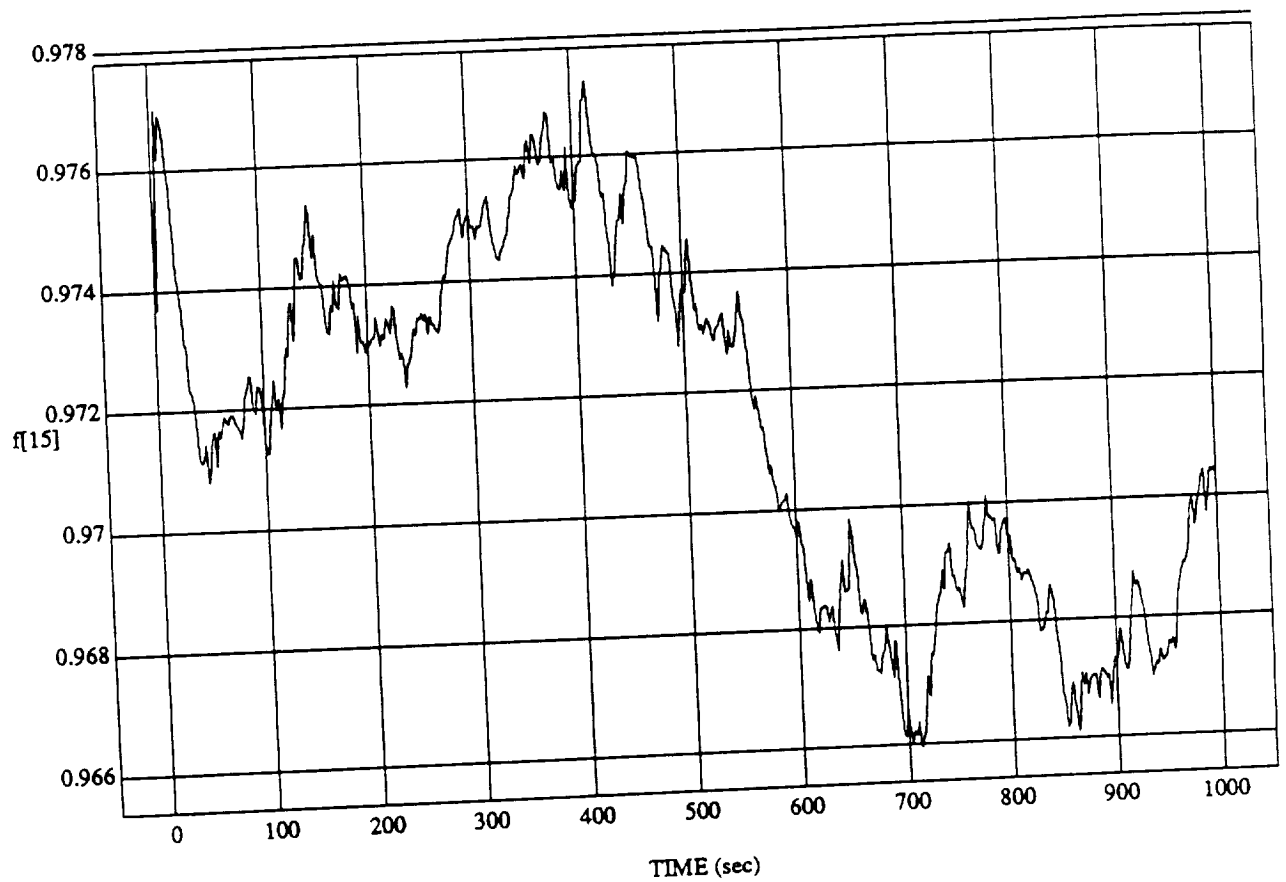
$f[8]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[15] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

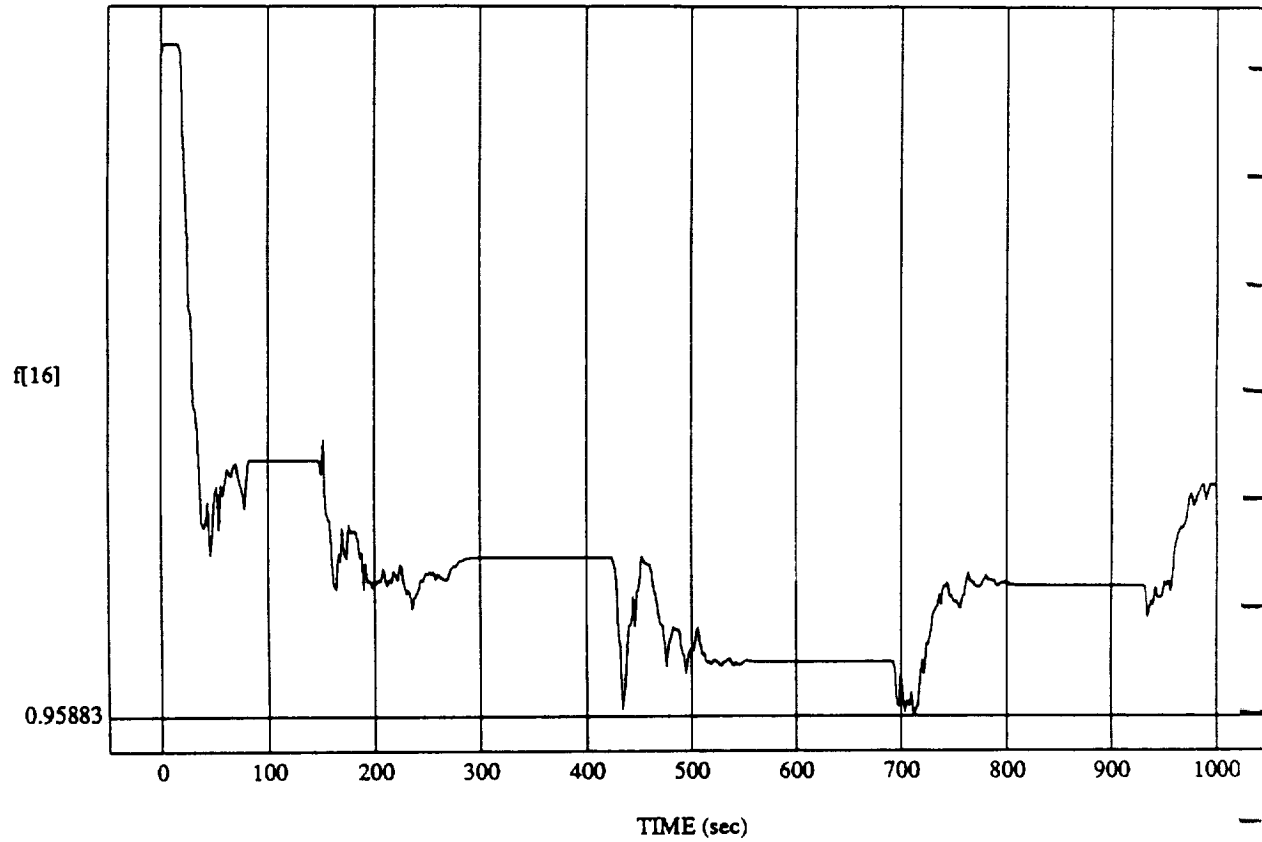


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[16] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

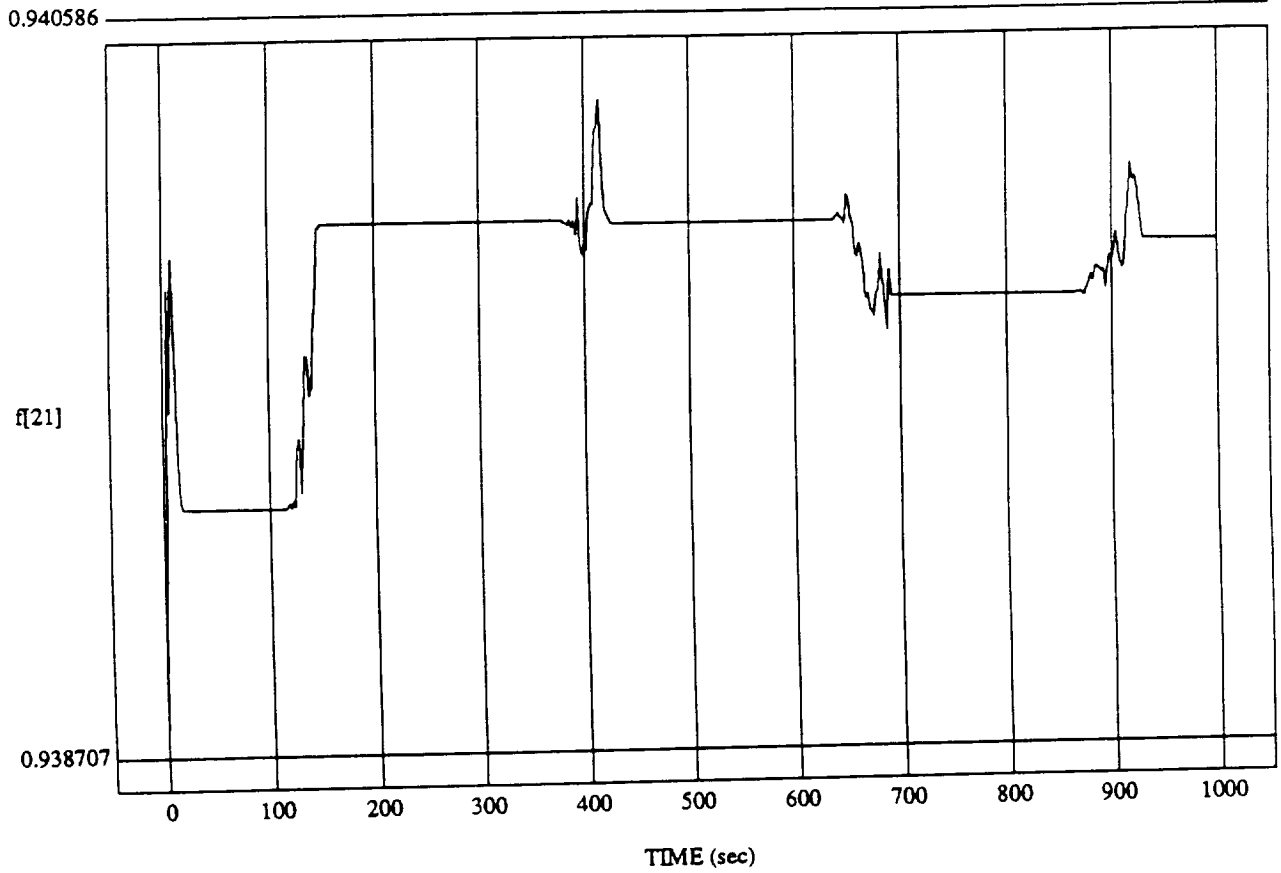
0.960749



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

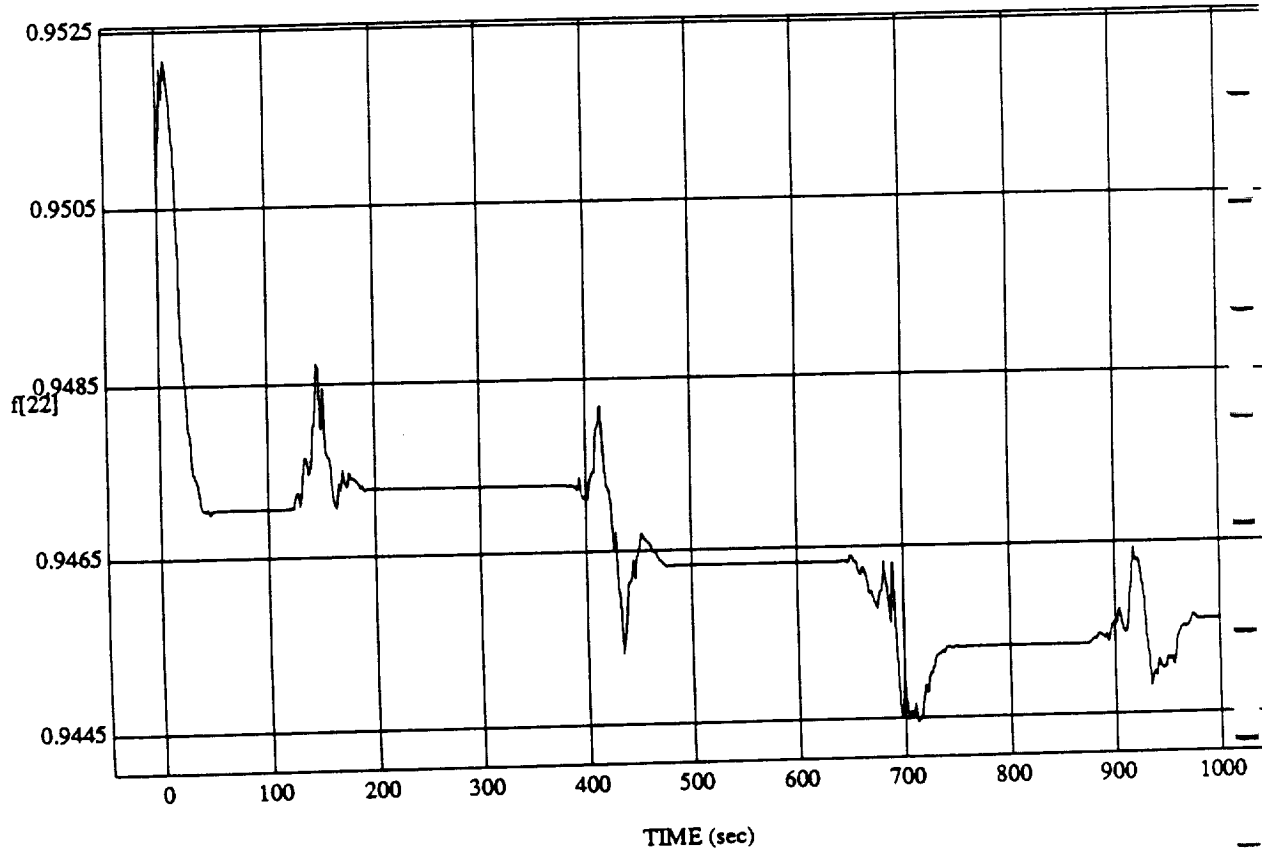
$f[21]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[22] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

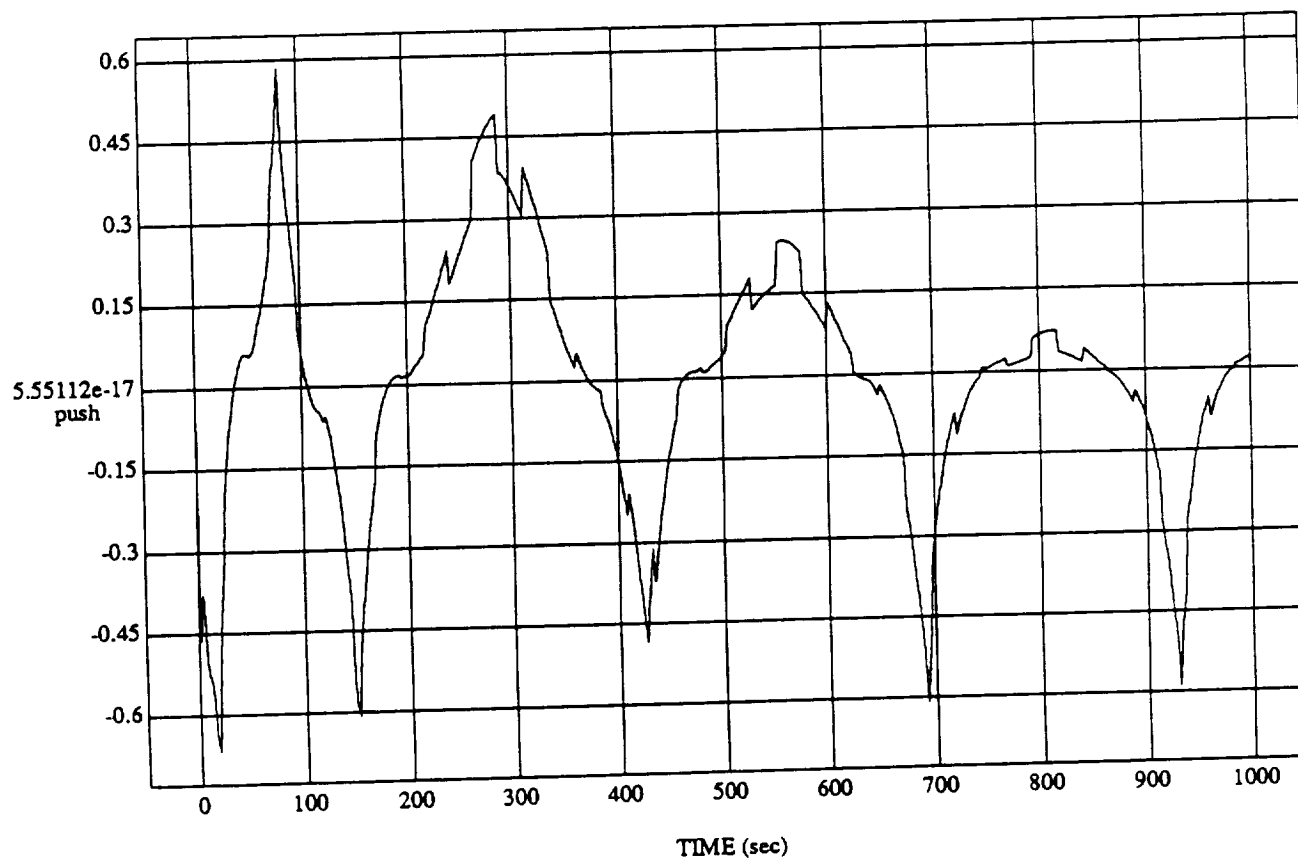


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

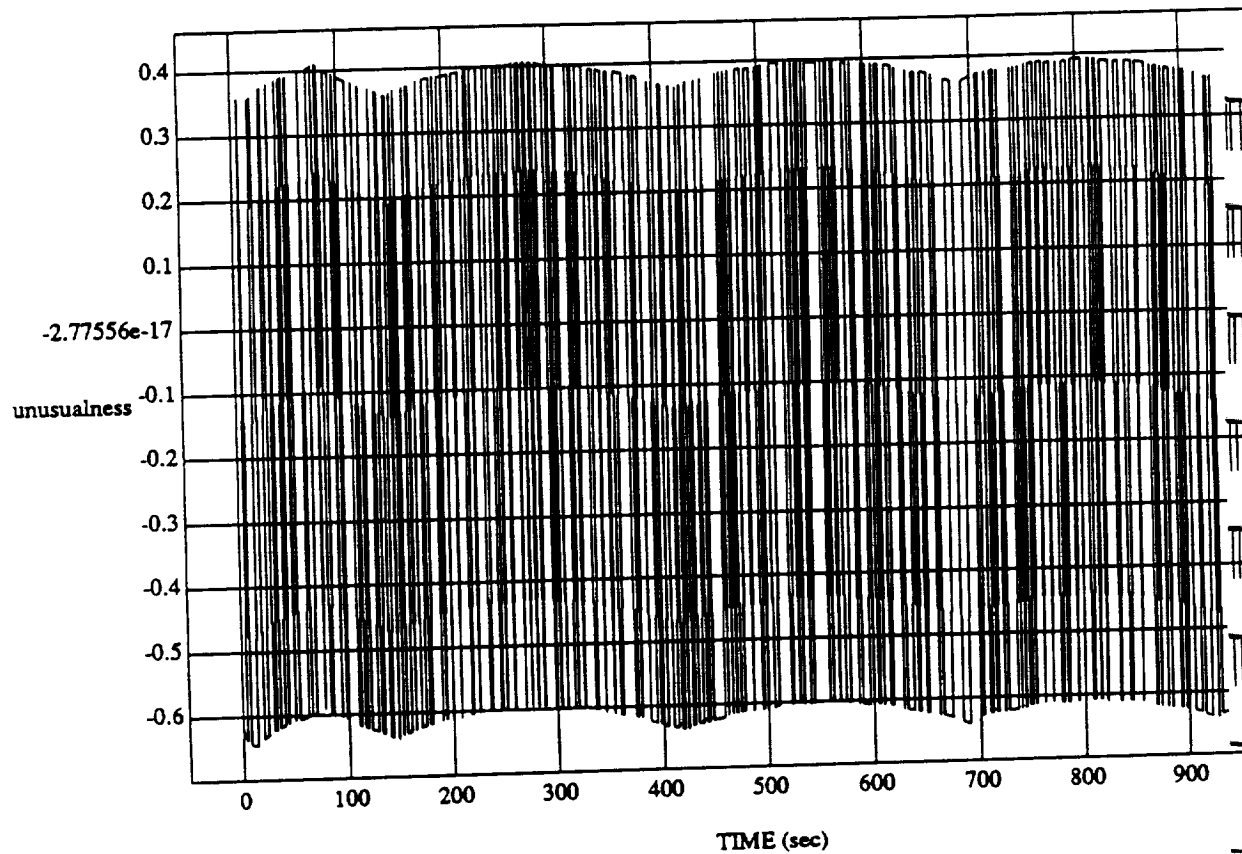
push vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

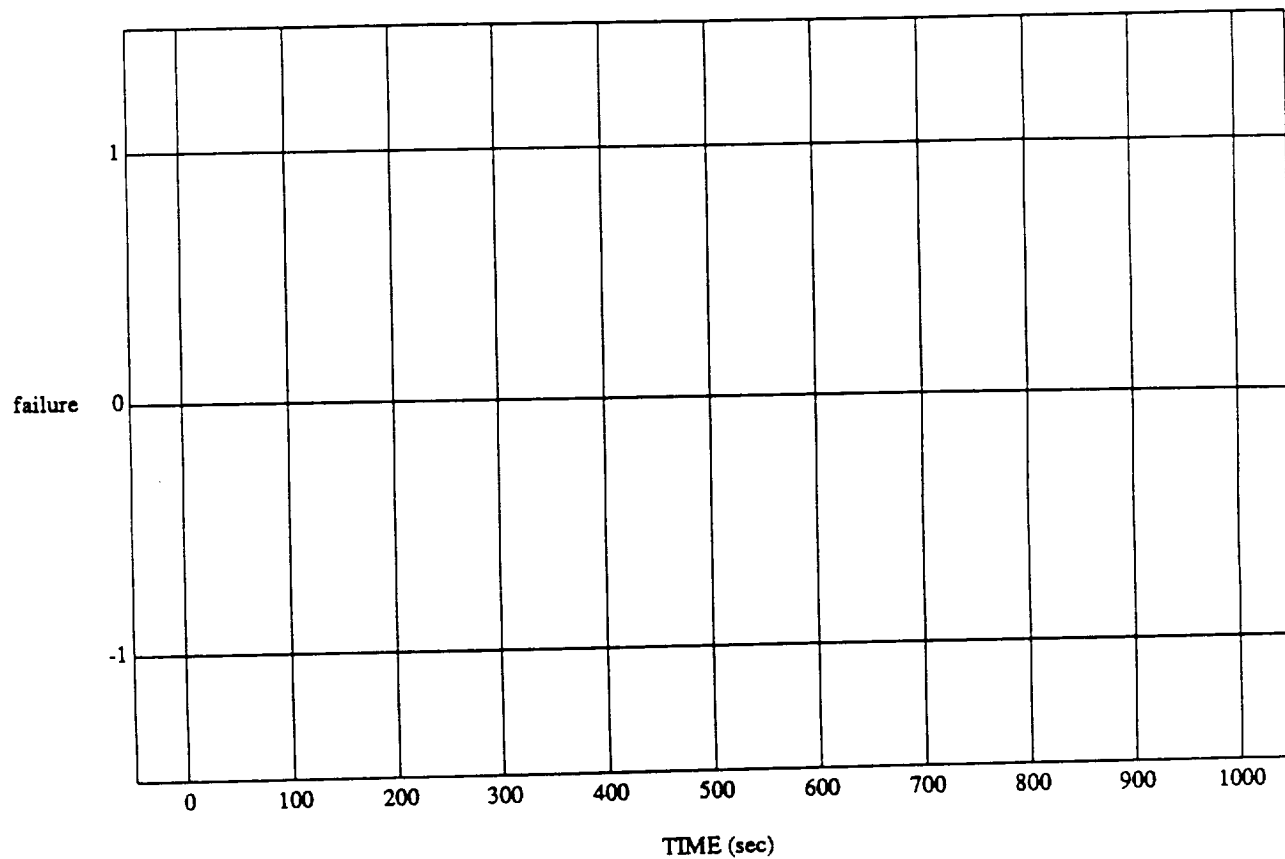
unusualness vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

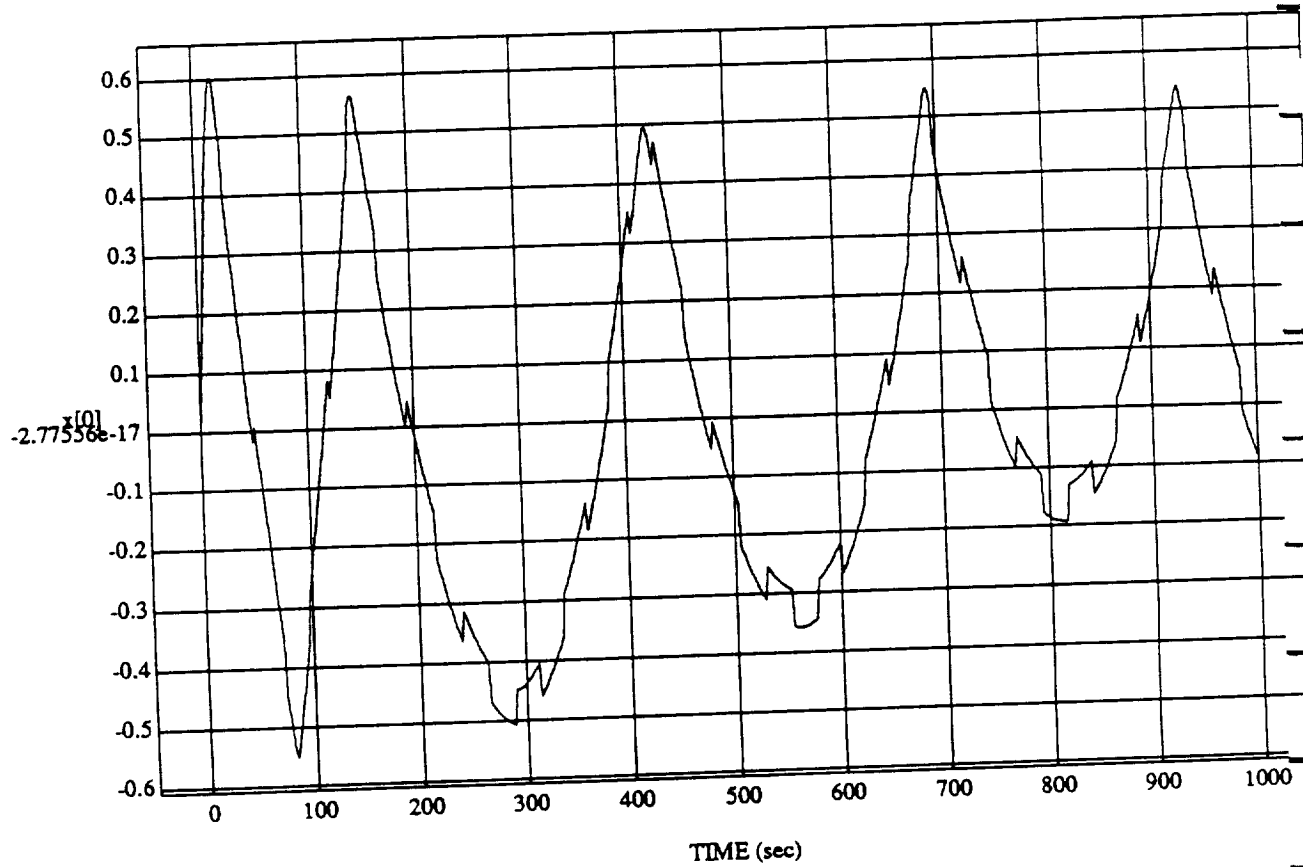
failure vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

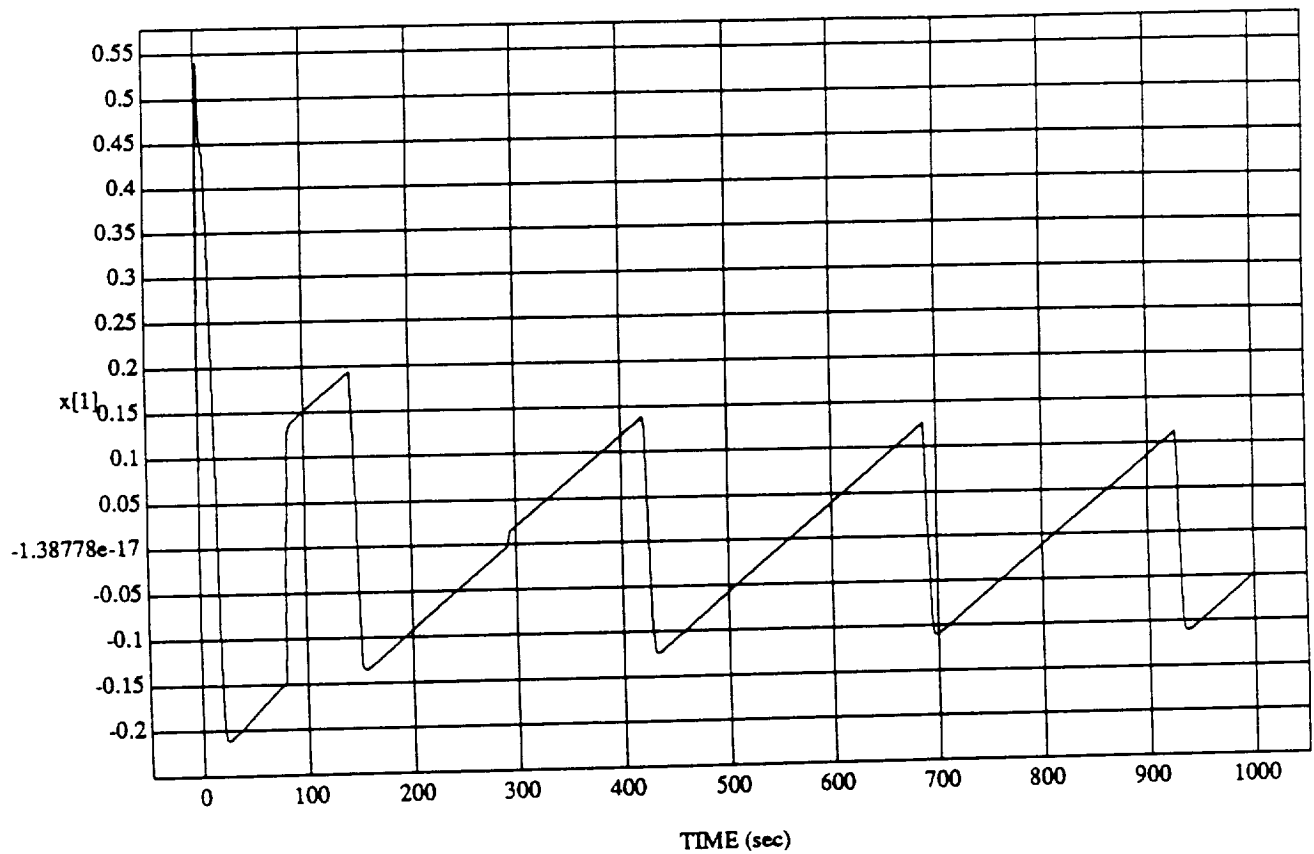
$x[0]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

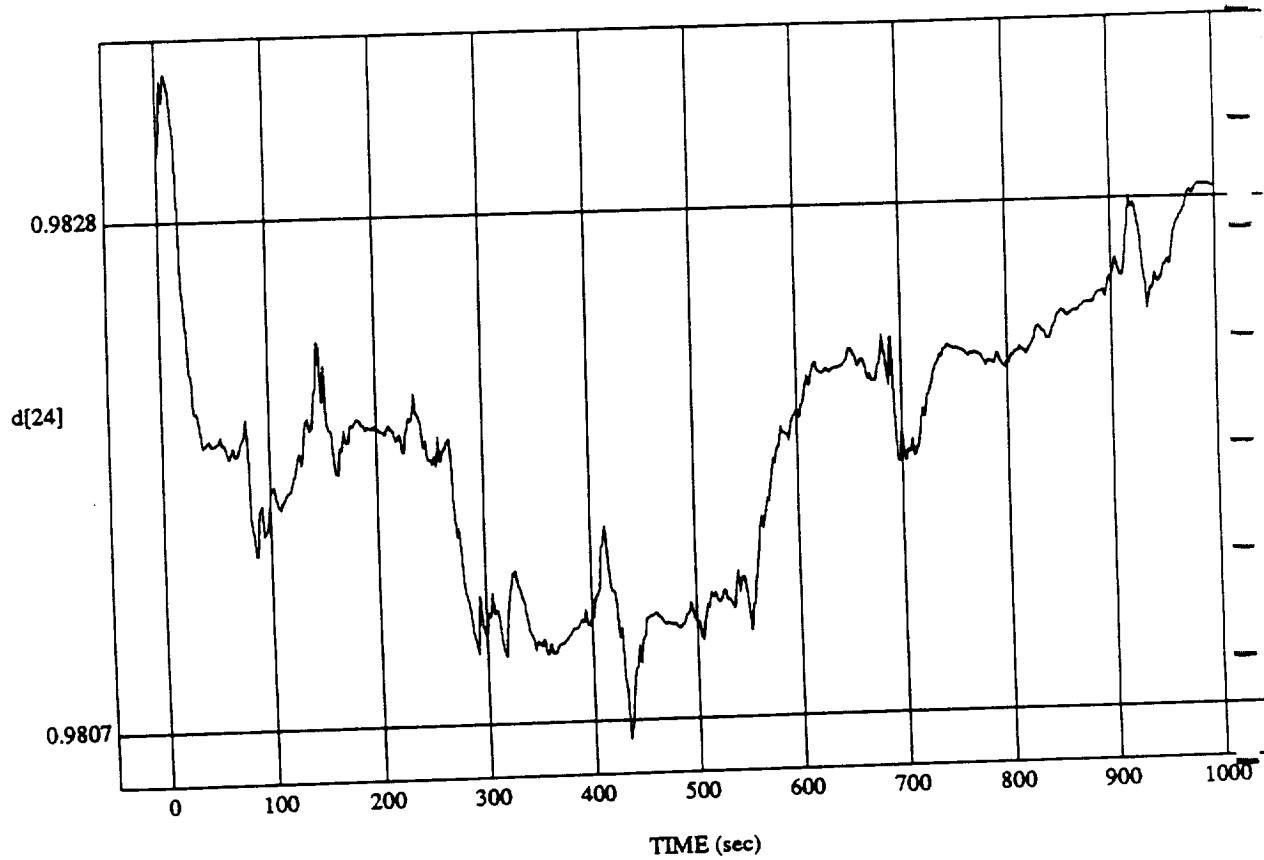
$x[1]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

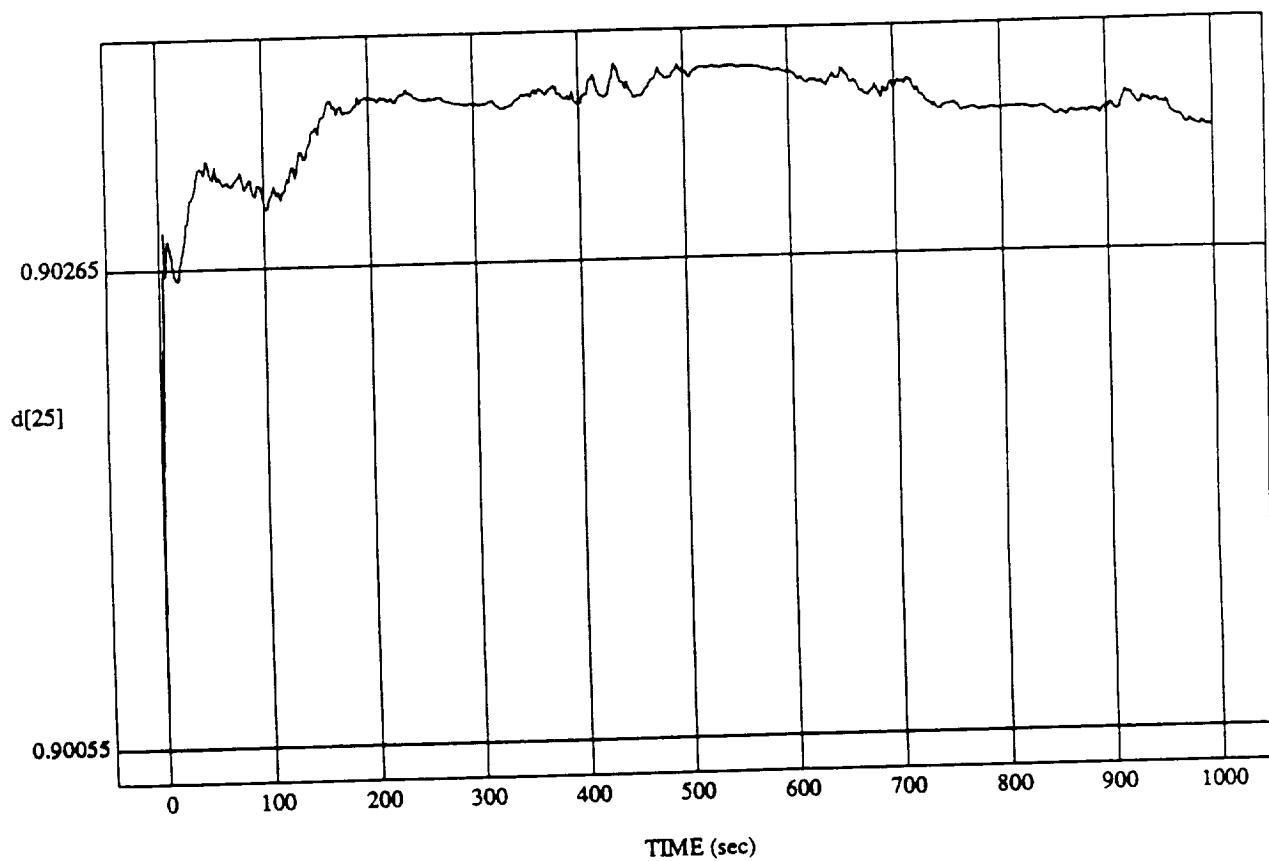
d[24] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

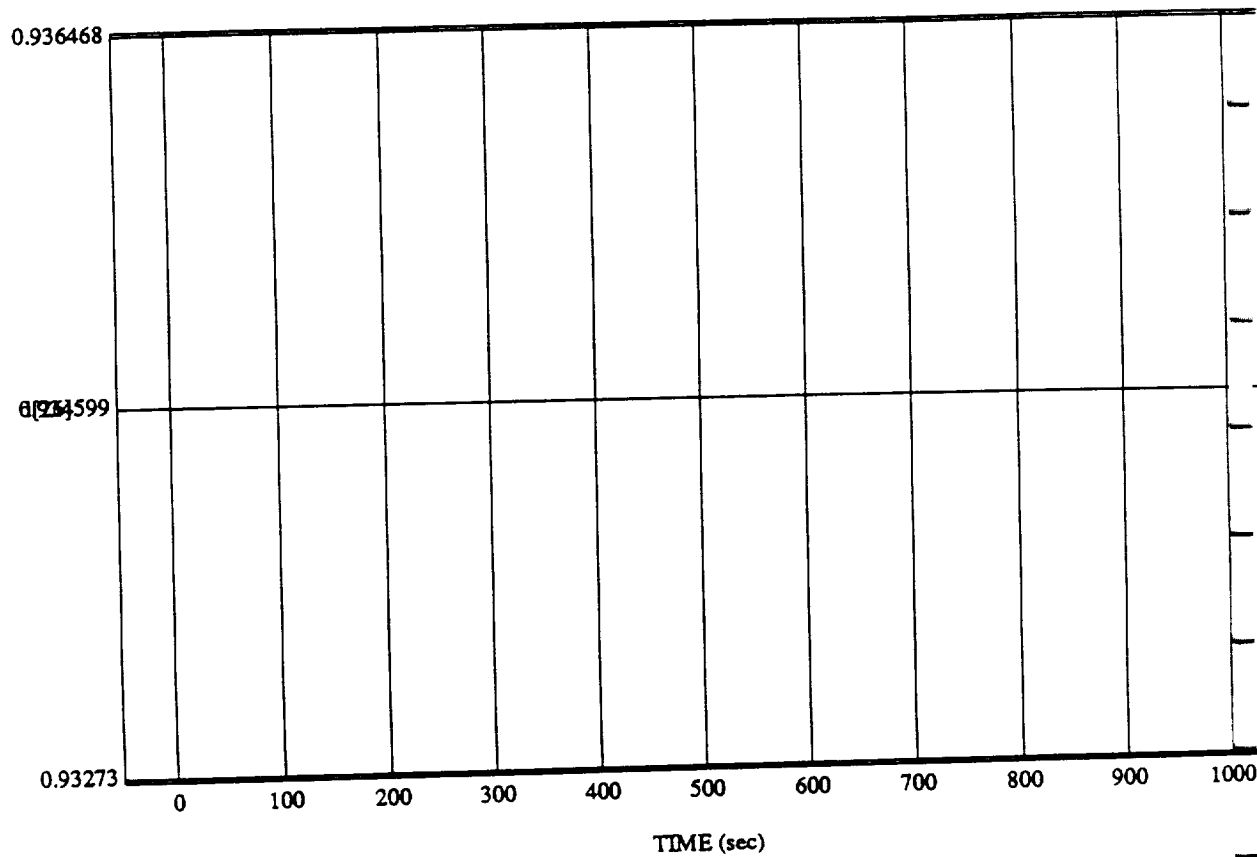
d[25] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[26] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

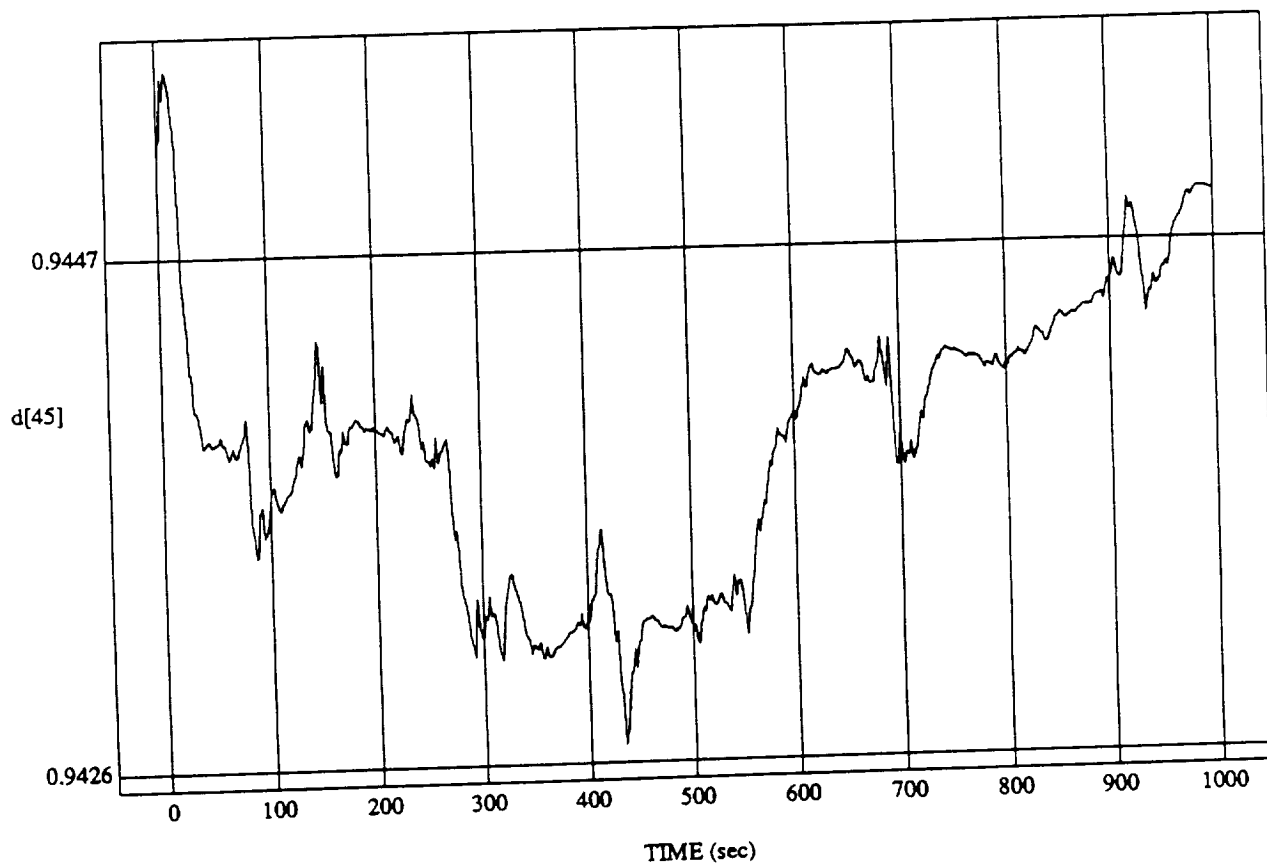


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[45] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

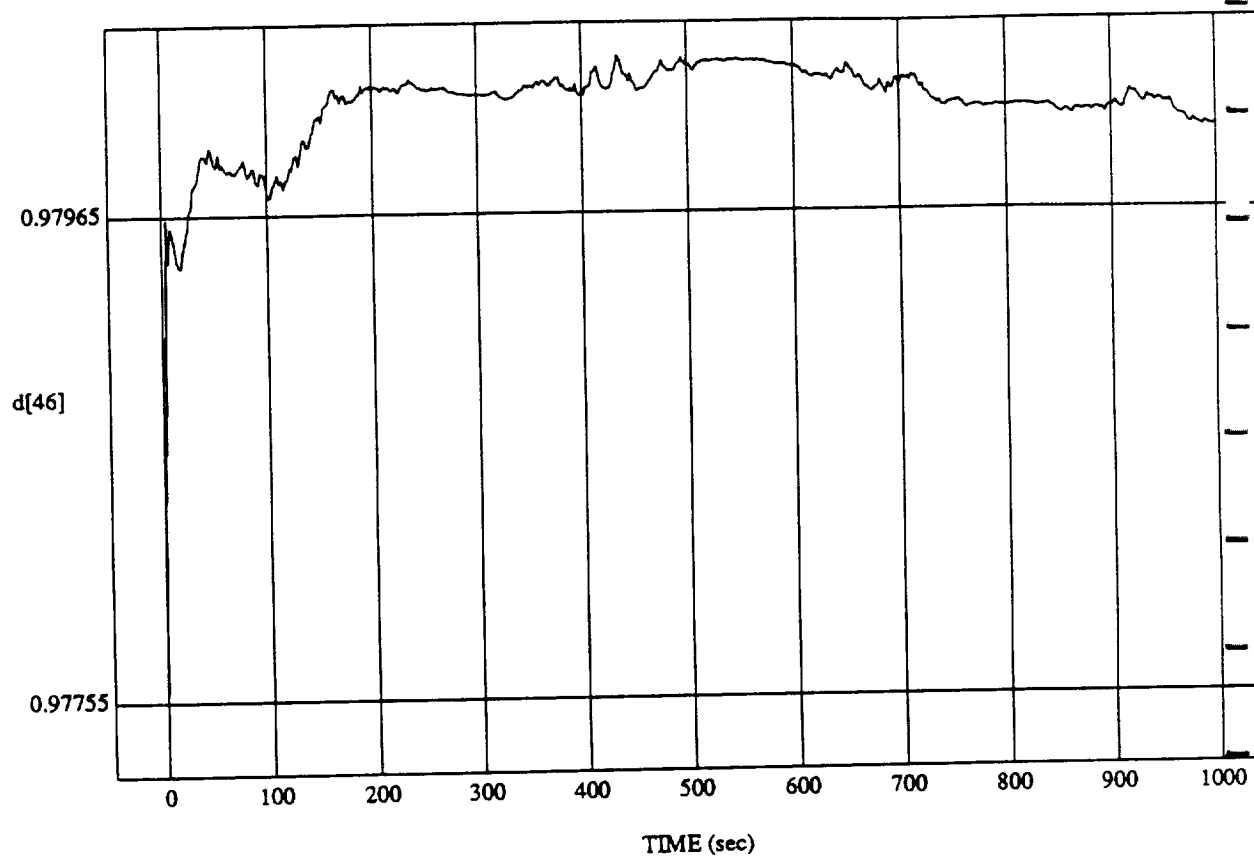


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[46] vs TIME

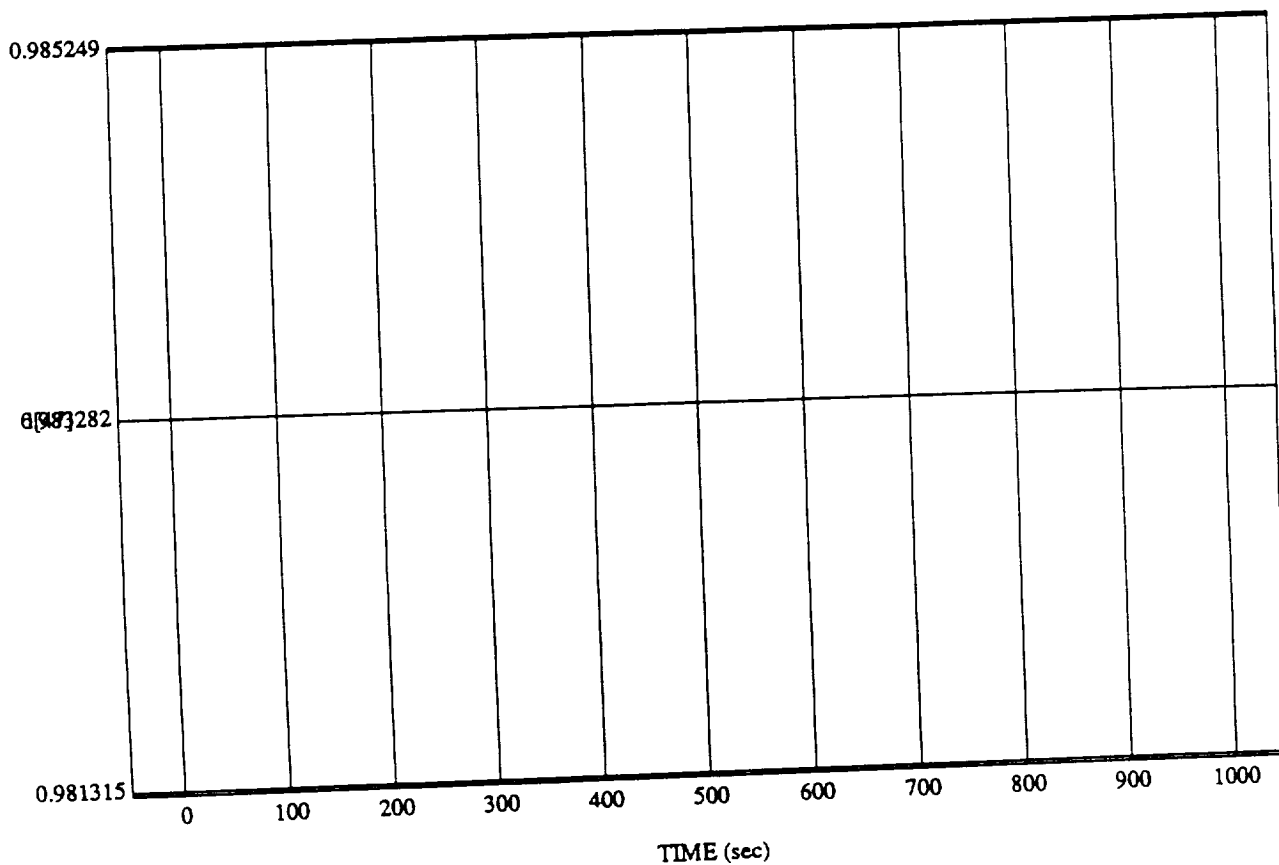
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[47] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

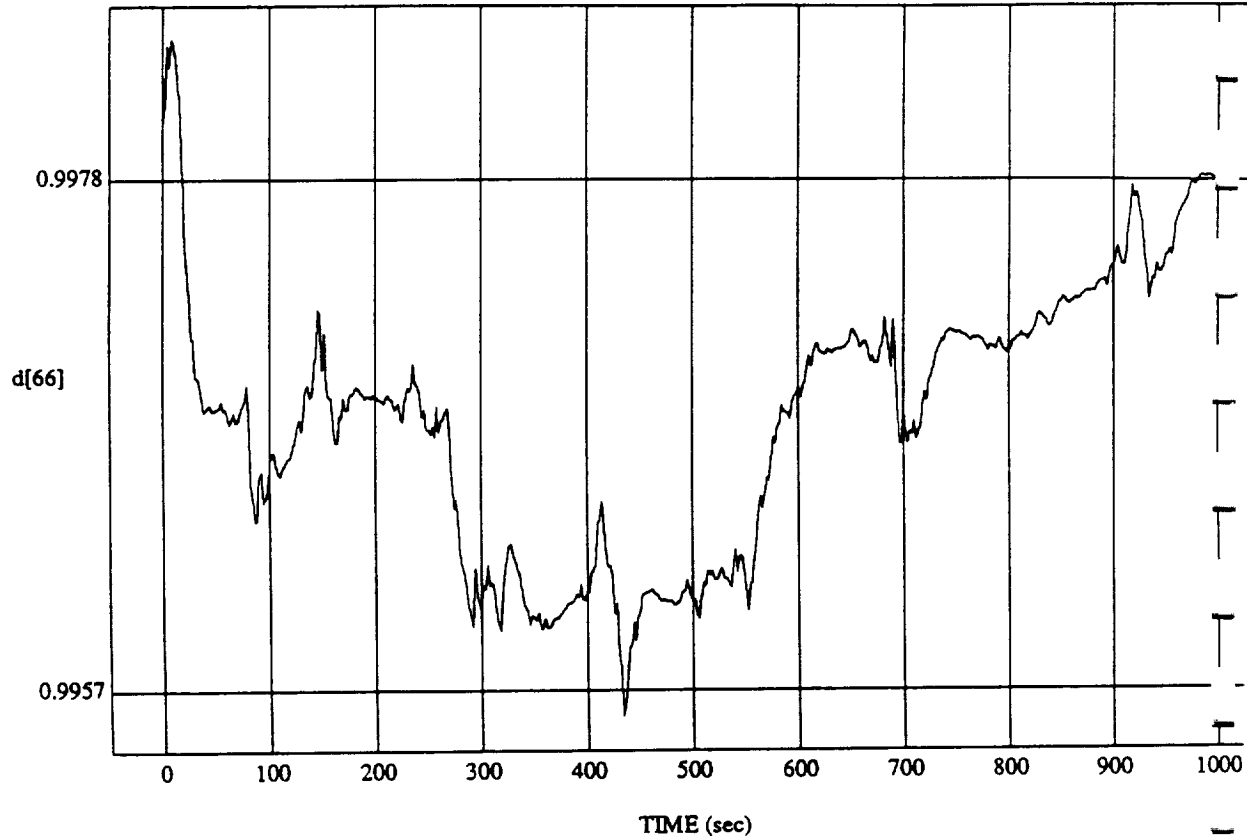


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[66] vs TIME

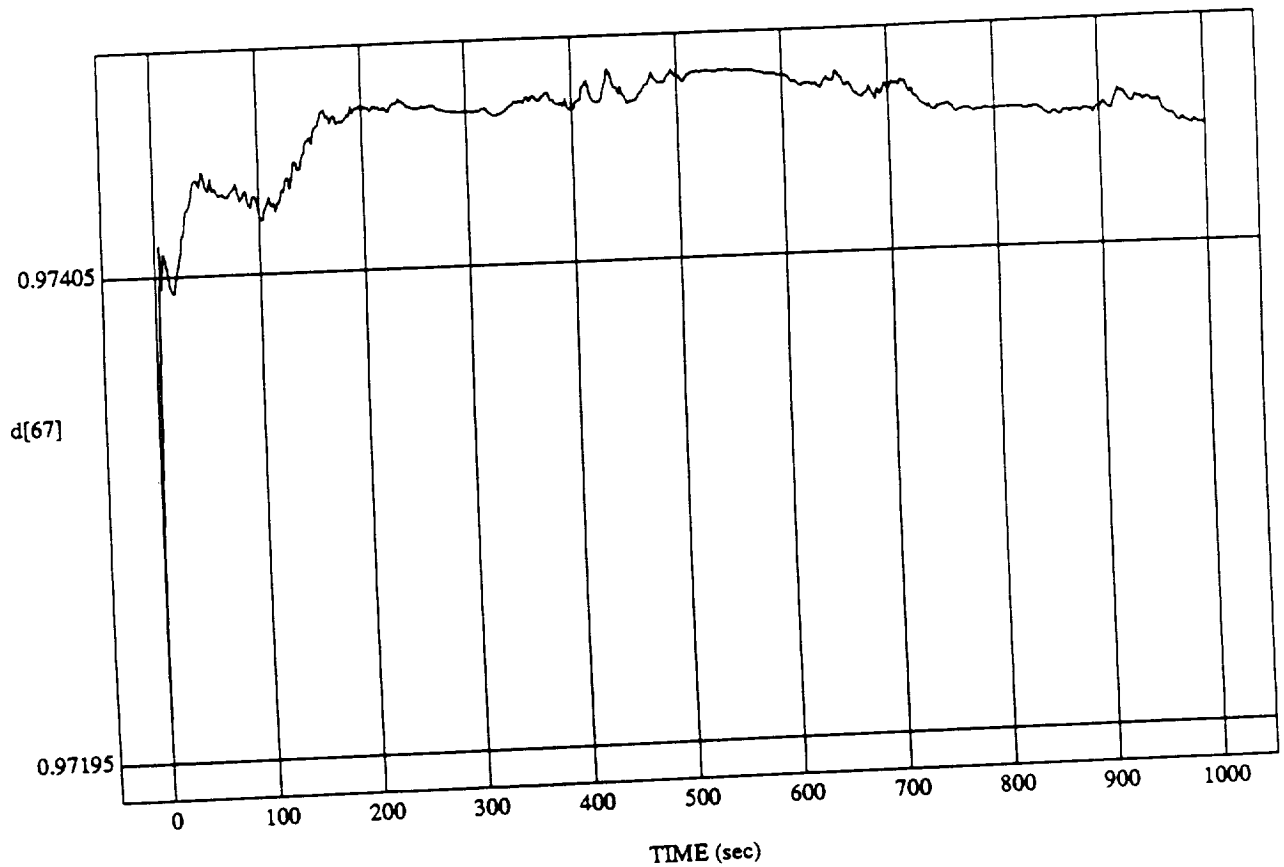
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.1cam2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[67] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

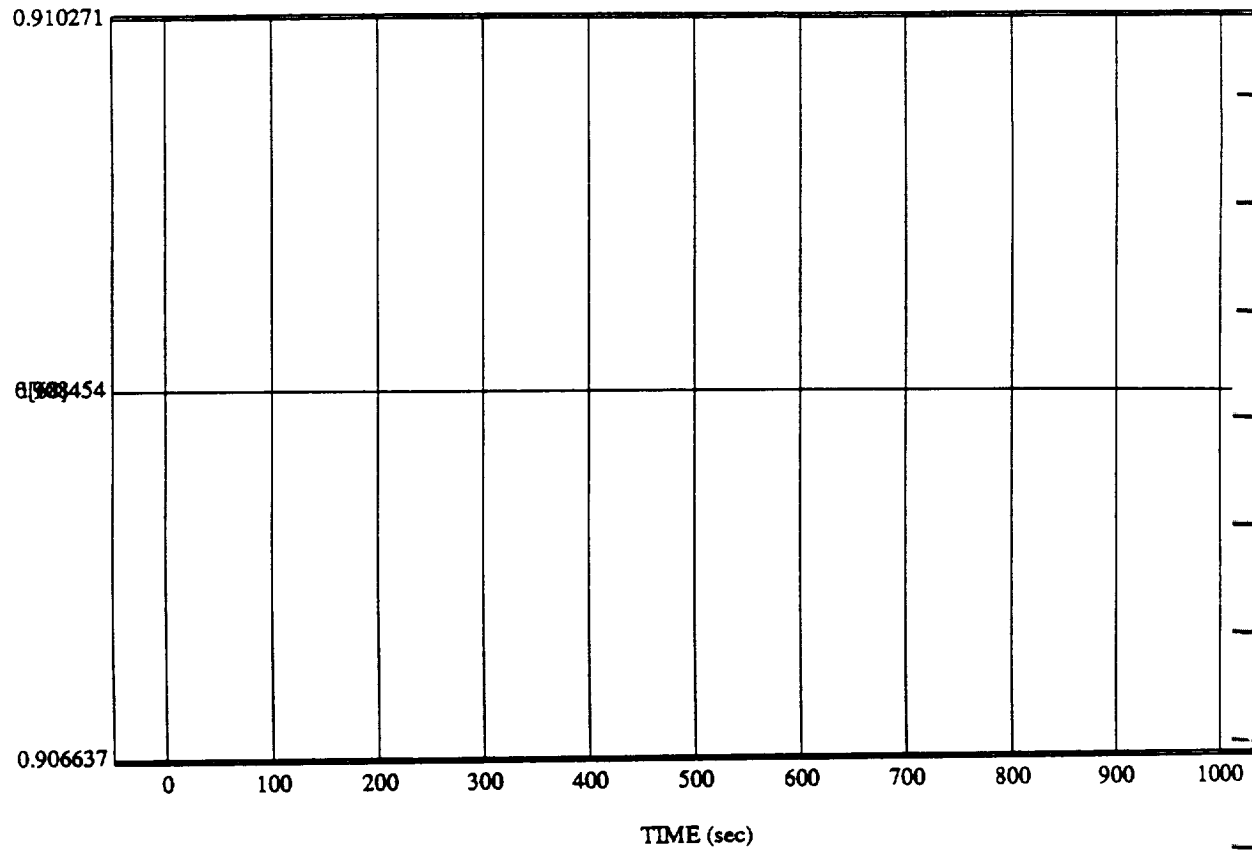


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[68] vs TIME

RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



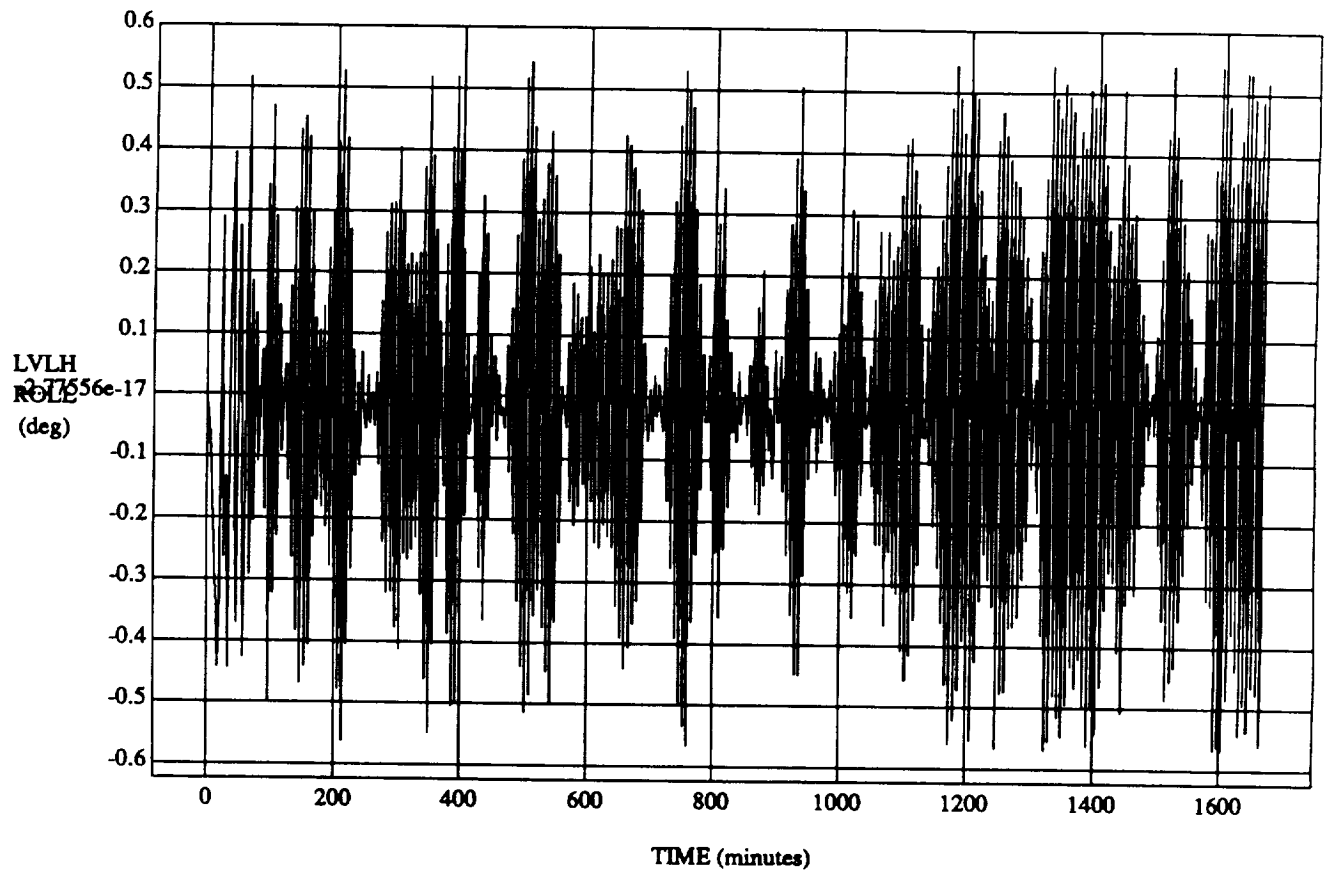




XIII

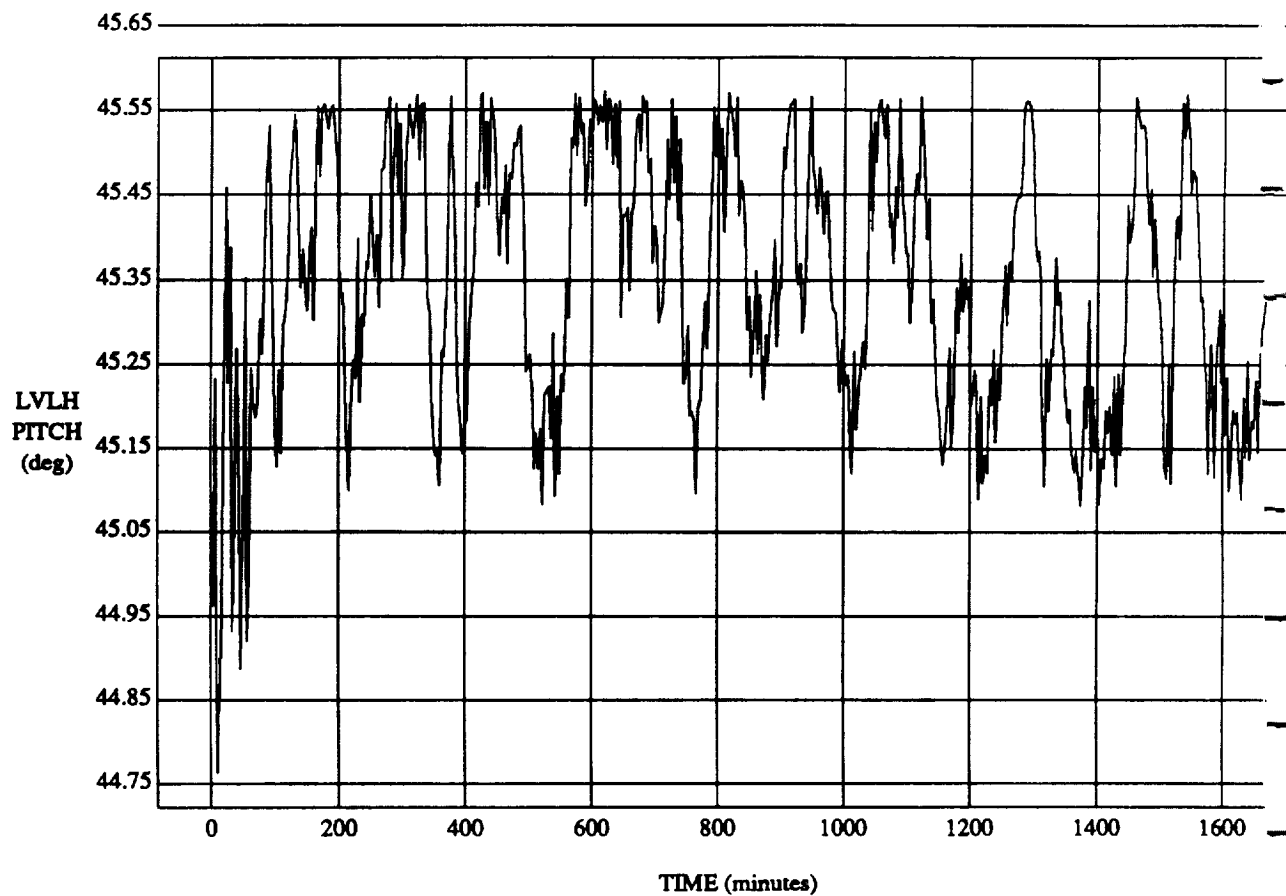
SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

**LVLH EULER PYR ROLL vs TIME**  
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

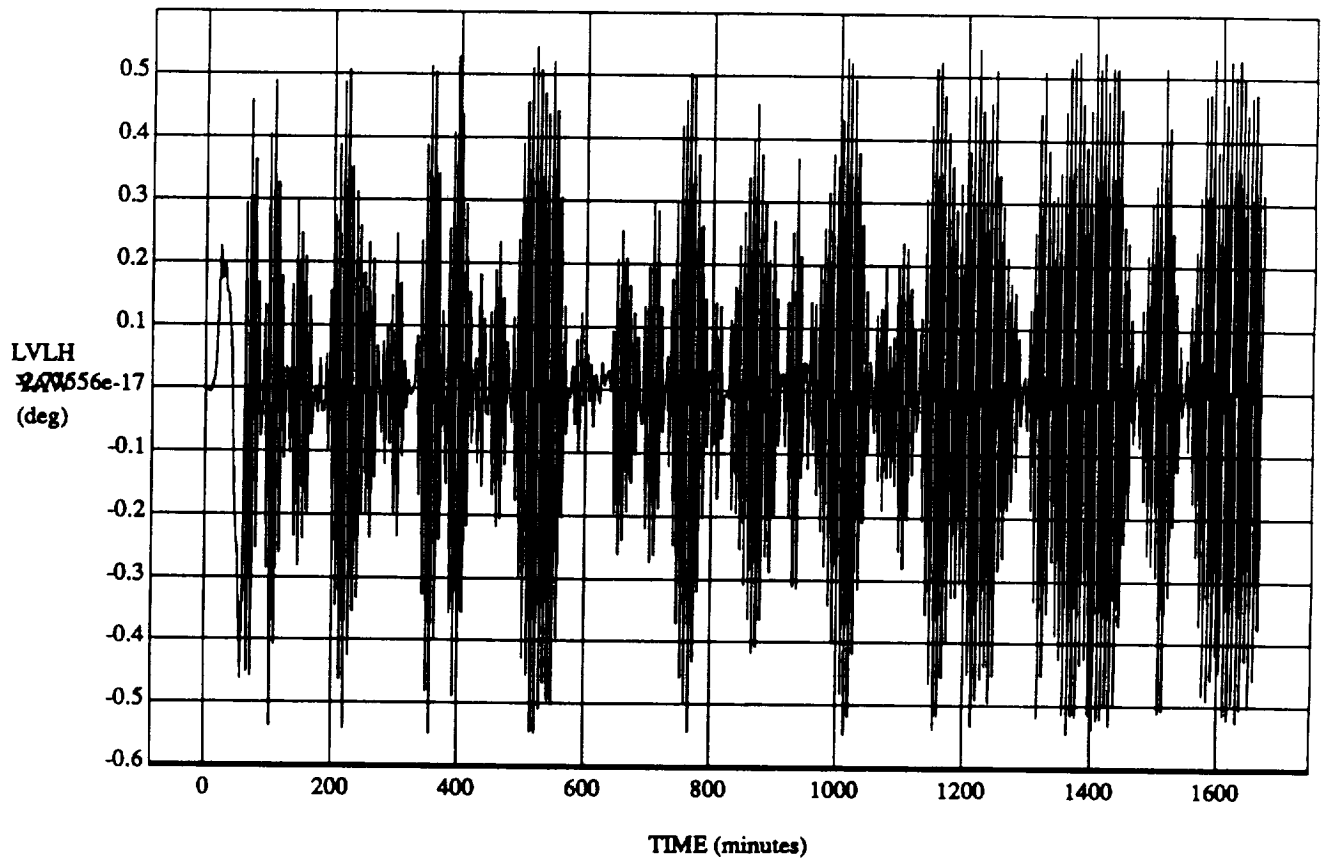
**LVLH EULER PYR PITCH vs TIME**  
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

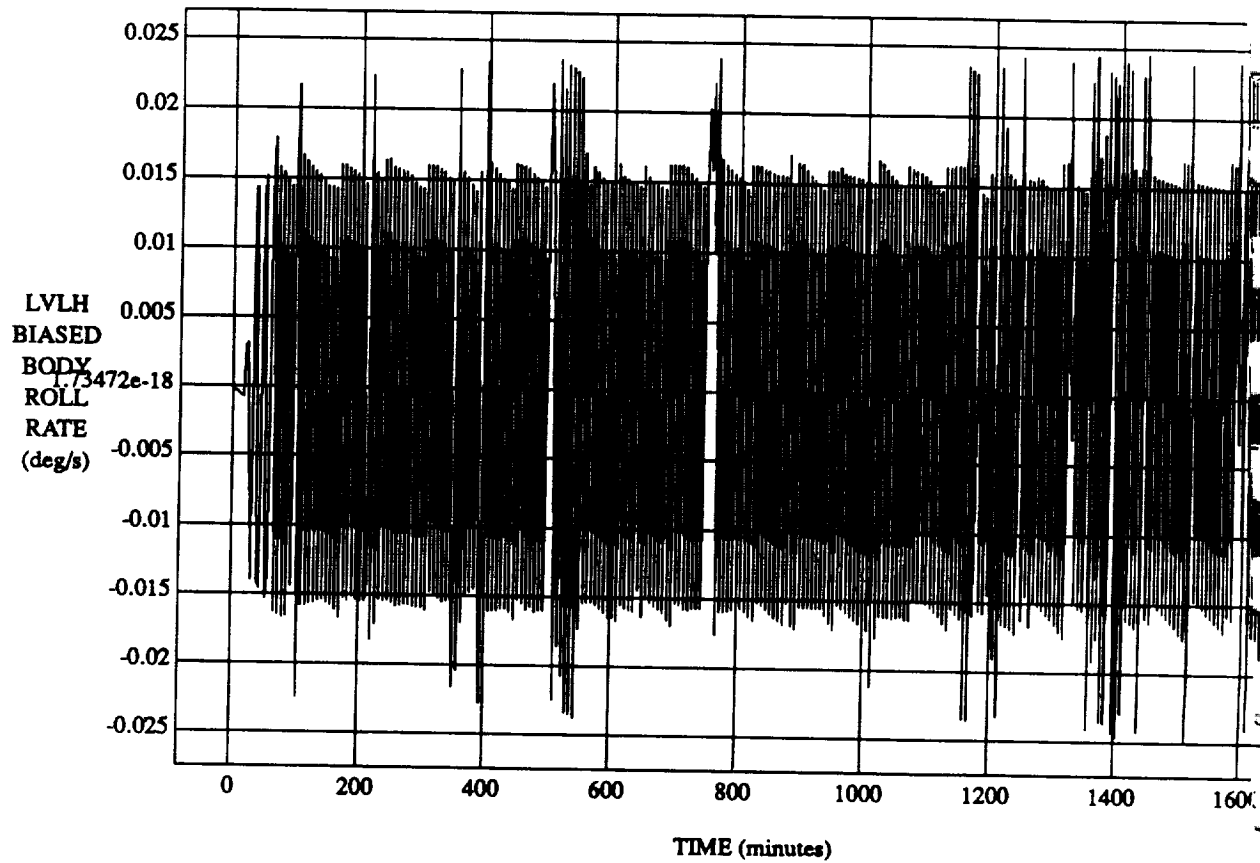
**LVLH EULER PYR YAW vs TIME**  
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

# LVLH BIASED BODY ROLL RATE vs TIME

RUN: Weights Updated By Rule Strength - 2 July 1992

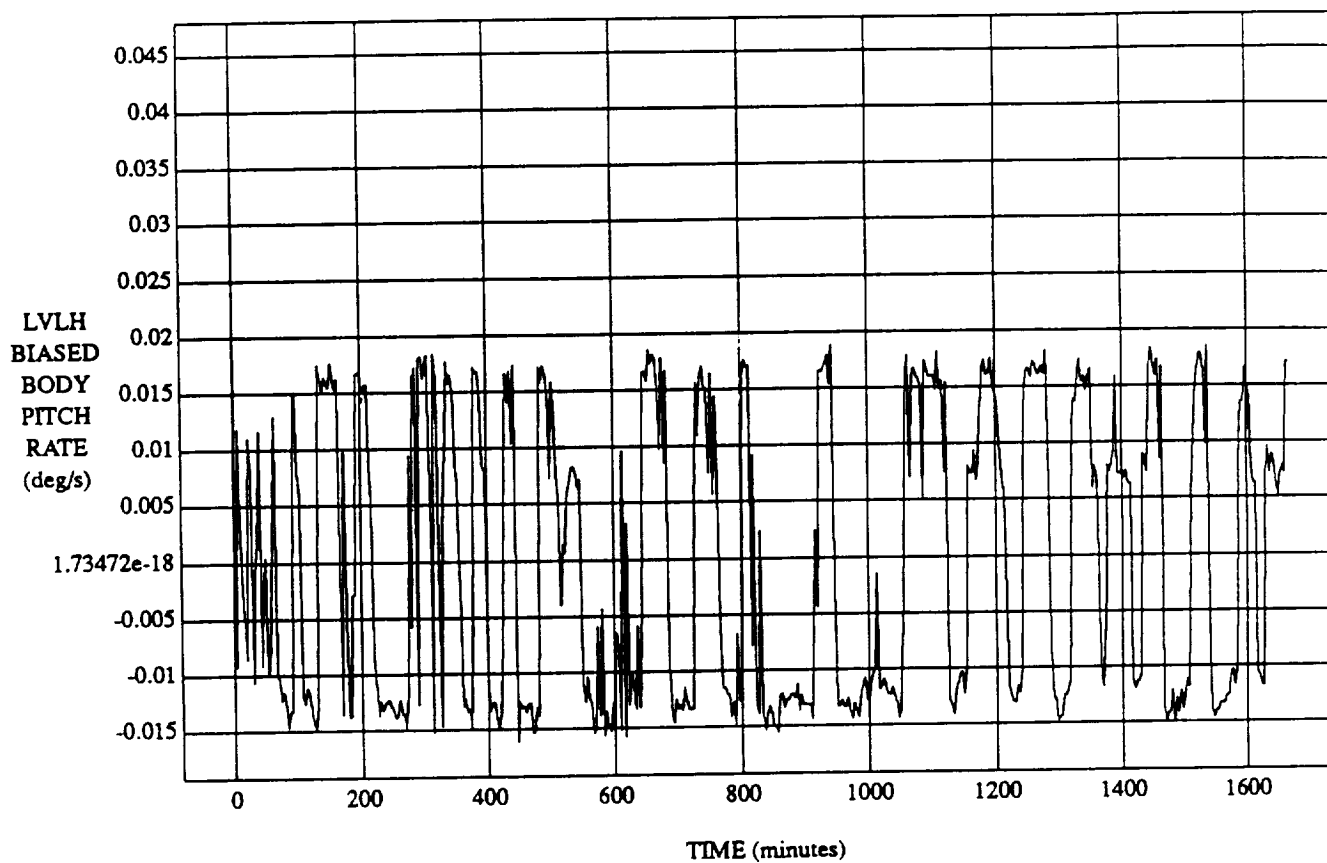


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

### LVLH BIASED BODY PITCH RATE vs TIME

RUN: Weights Updated By Rule Strength - 2 July 1992

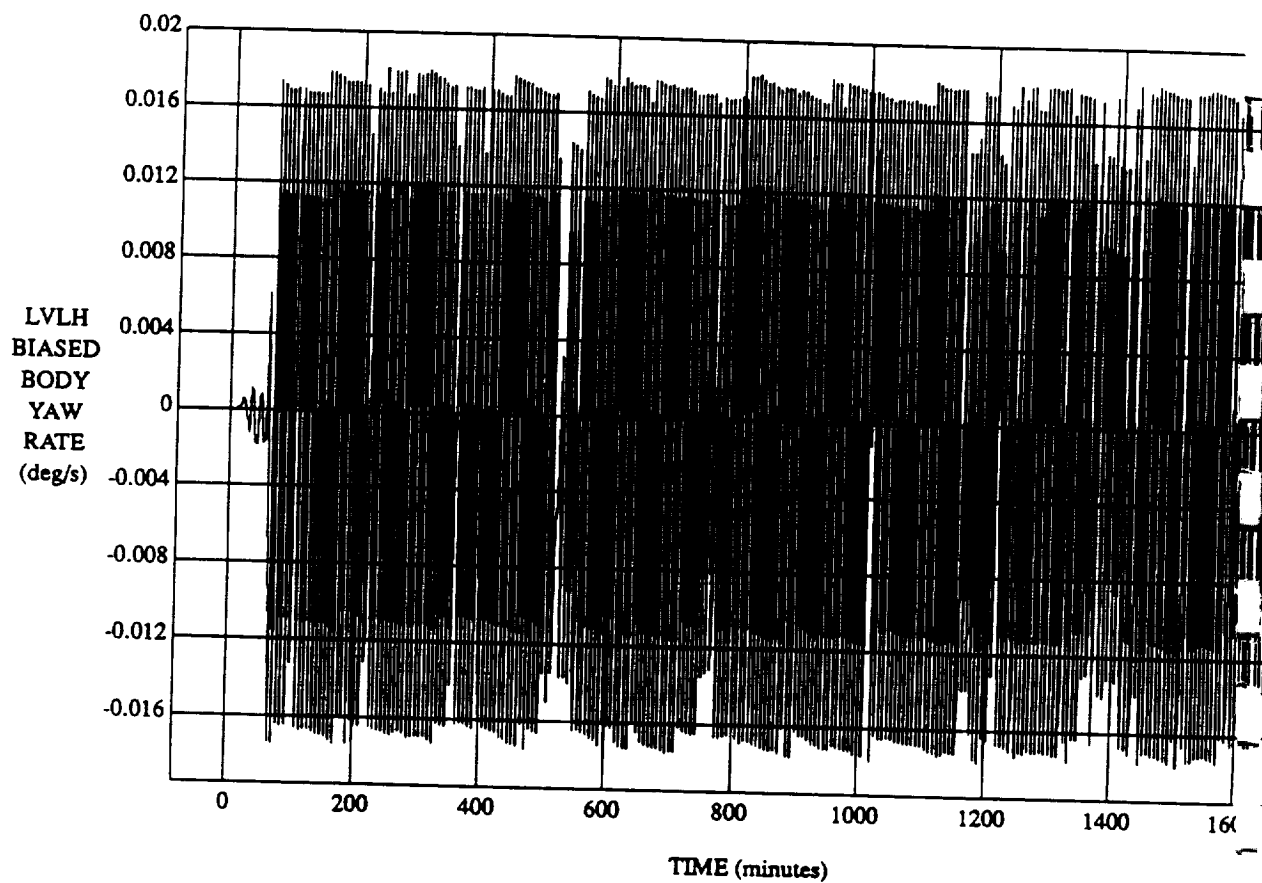


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

# LVLH BIASED BODY YAW RATE vs TIME

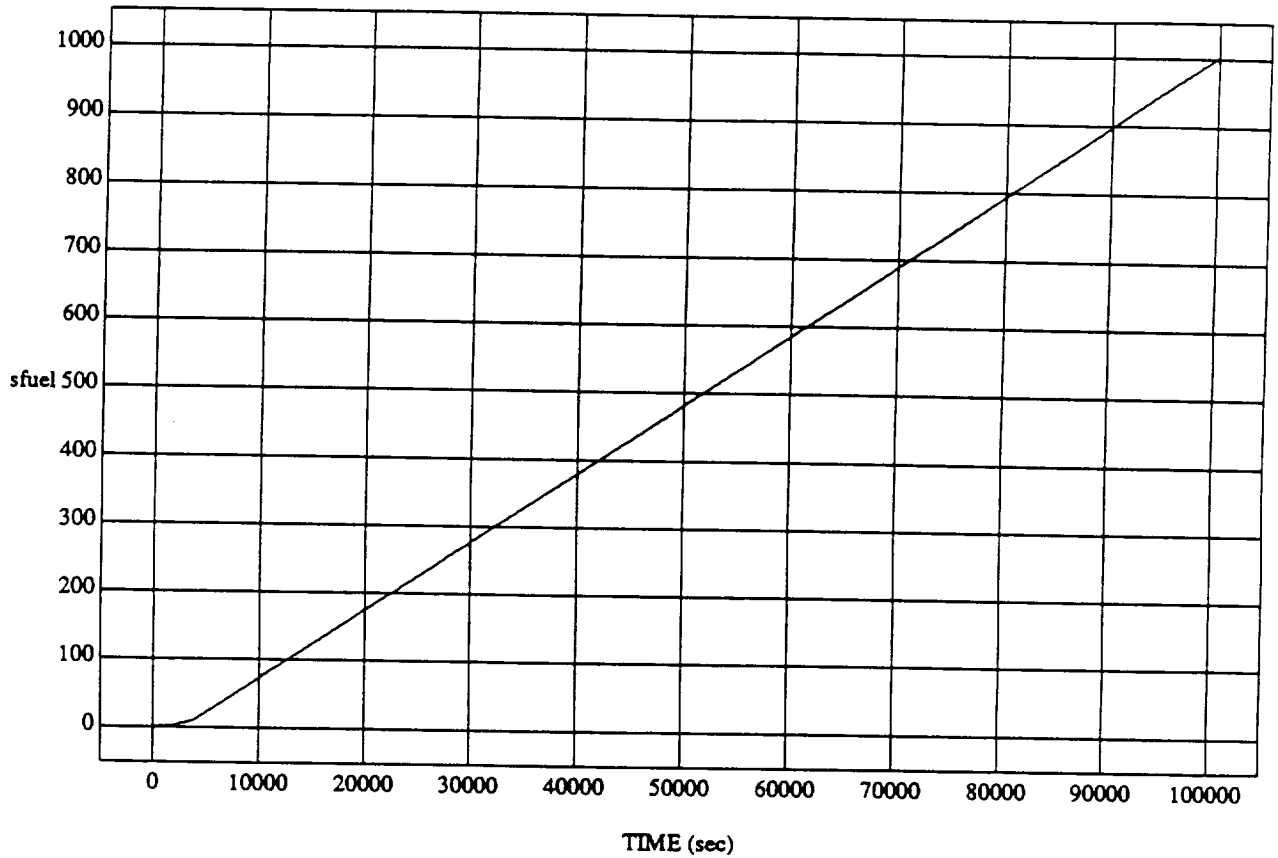
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

**sfuel vs TIME**  
RUN: Weights Updated By Rule Strength - 2 July 1992



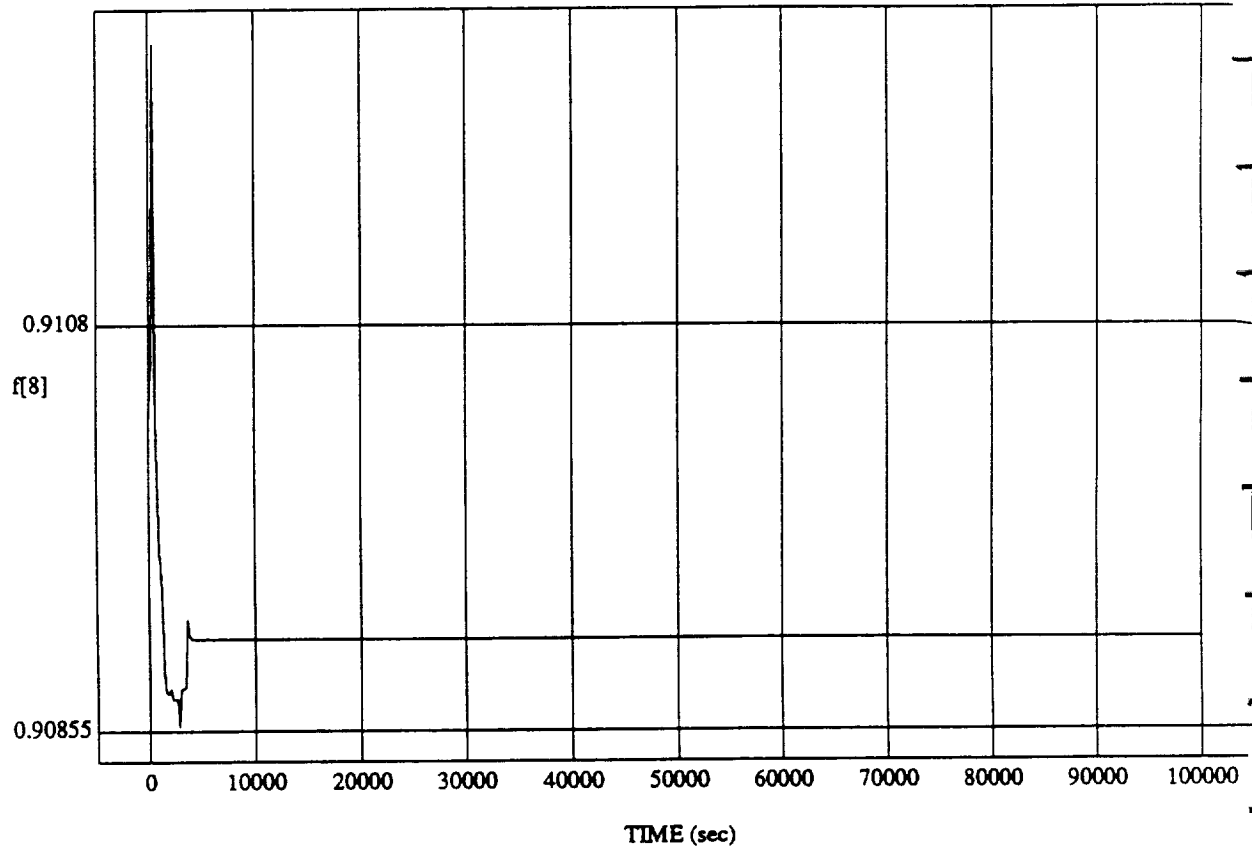
MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[8]$  vs TIME

RUN: Weights Updated By Rule Strength - 2 July 1992

0.91305

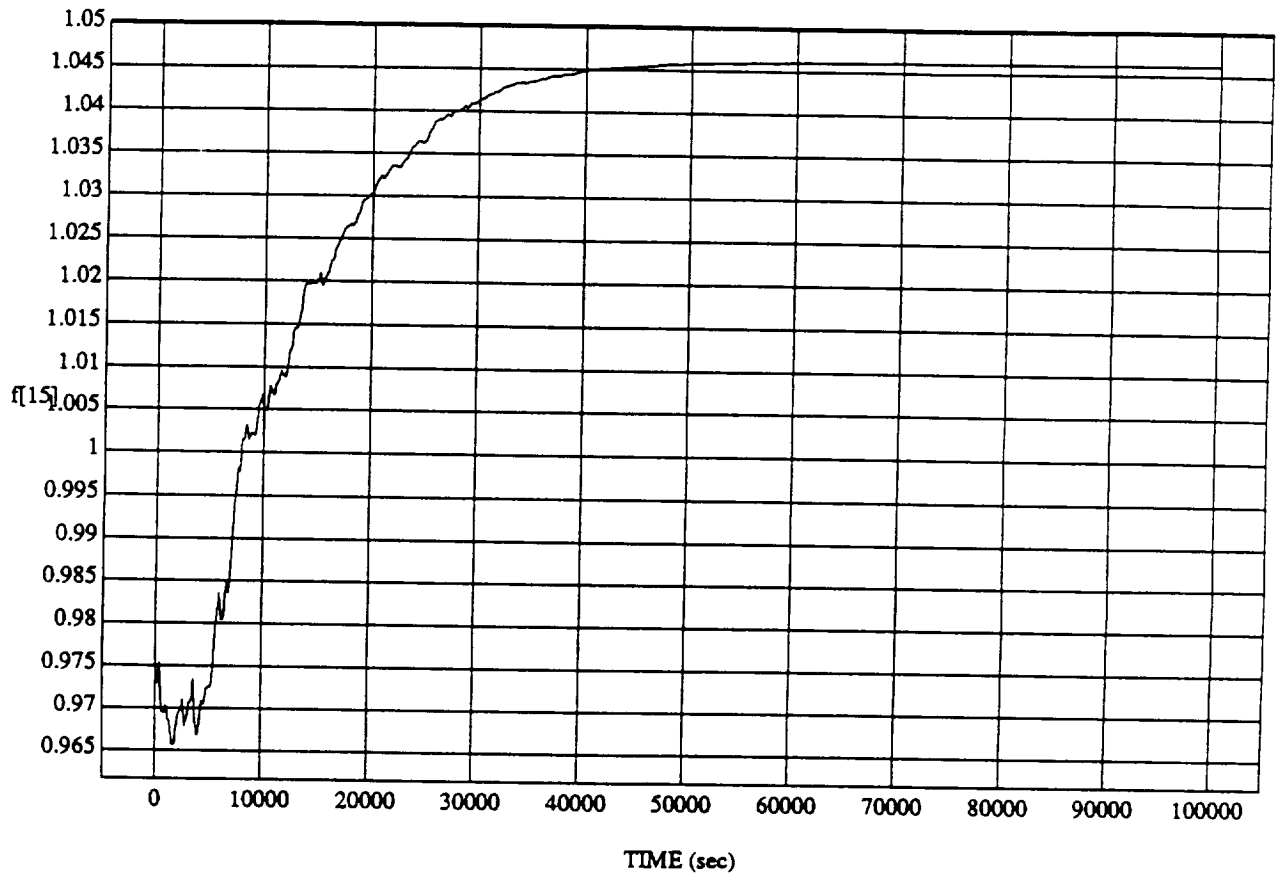


MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$f[15]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

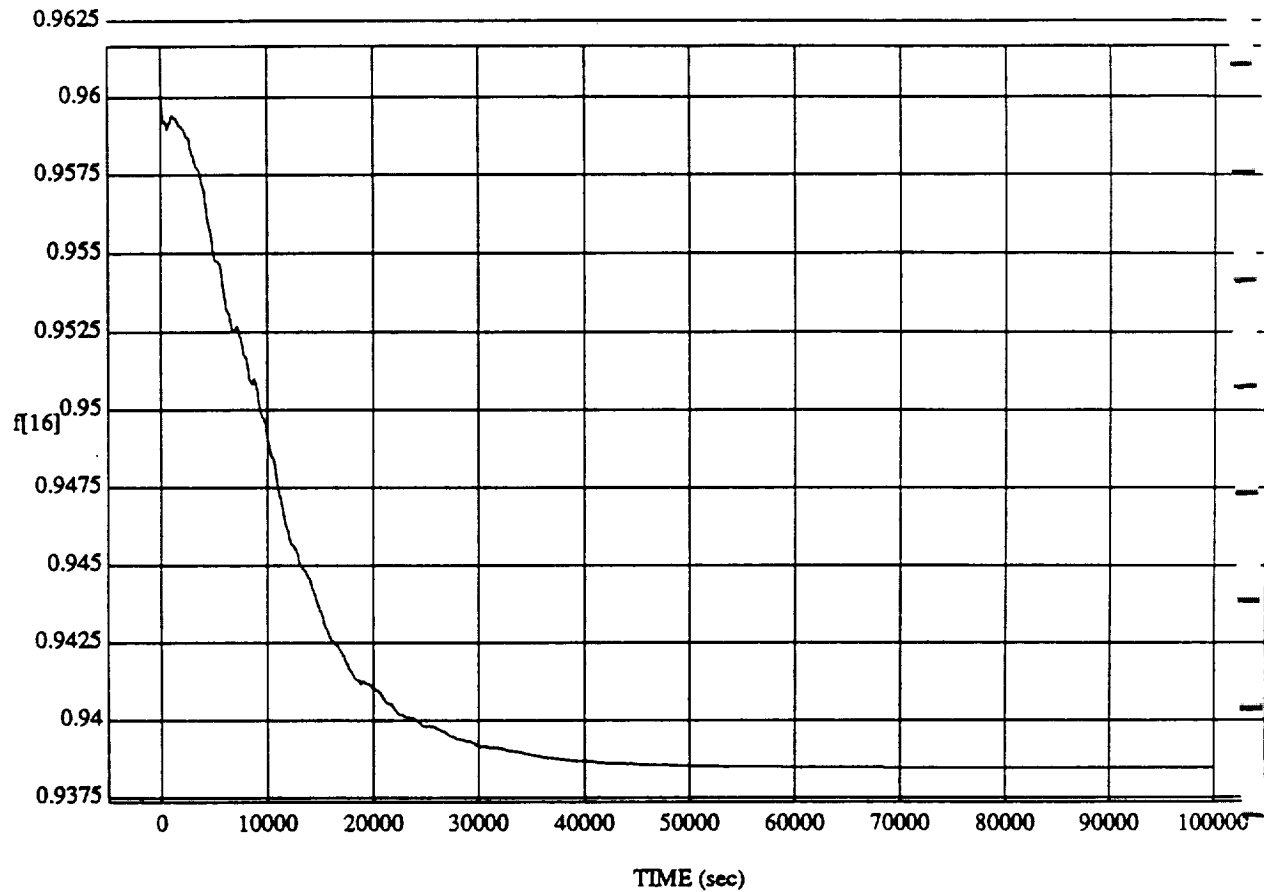


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[16] vs TIME

RUN: Weights Updated By Rule Strength - 2 July 1992

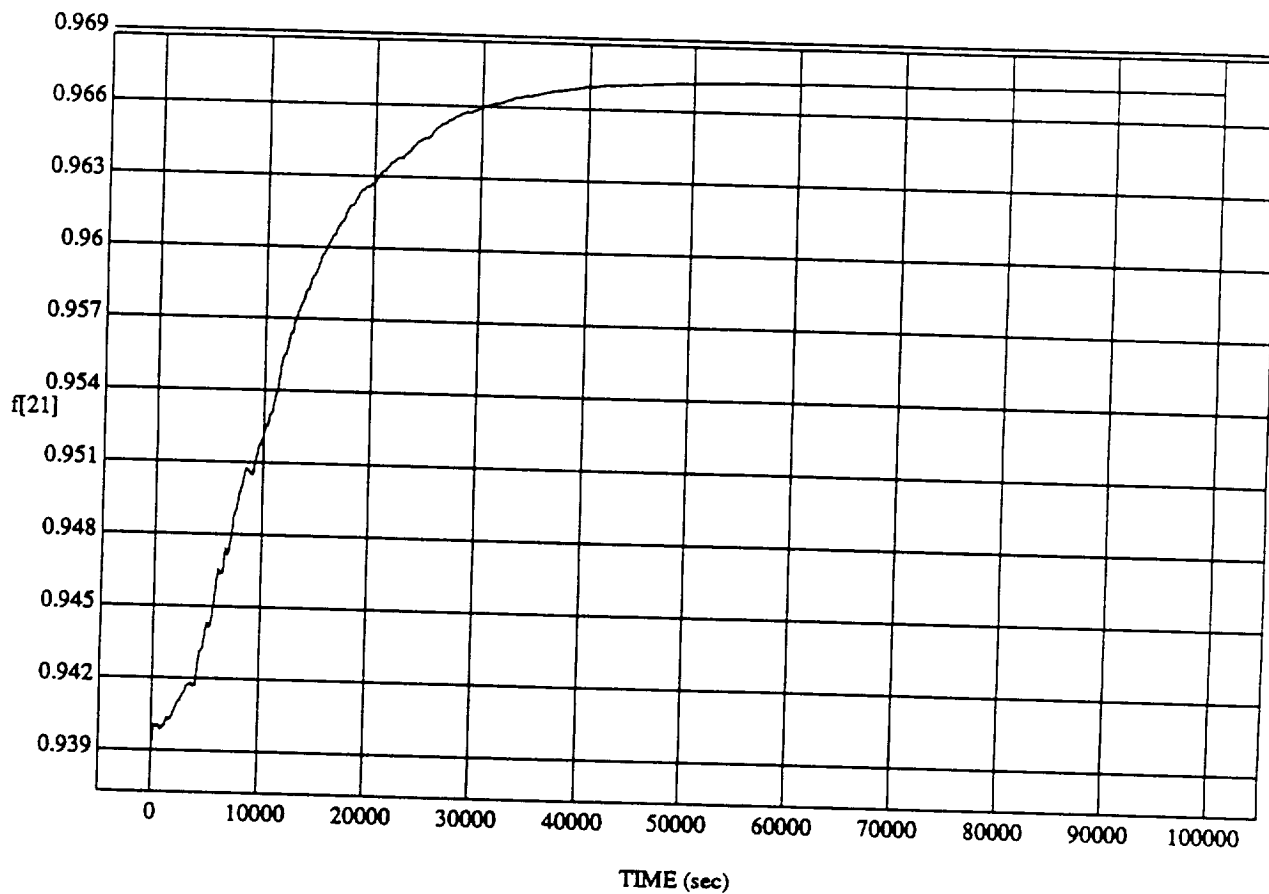


MODULE: ORB\_FUZZ\_BATCH.learn2

DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[21] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

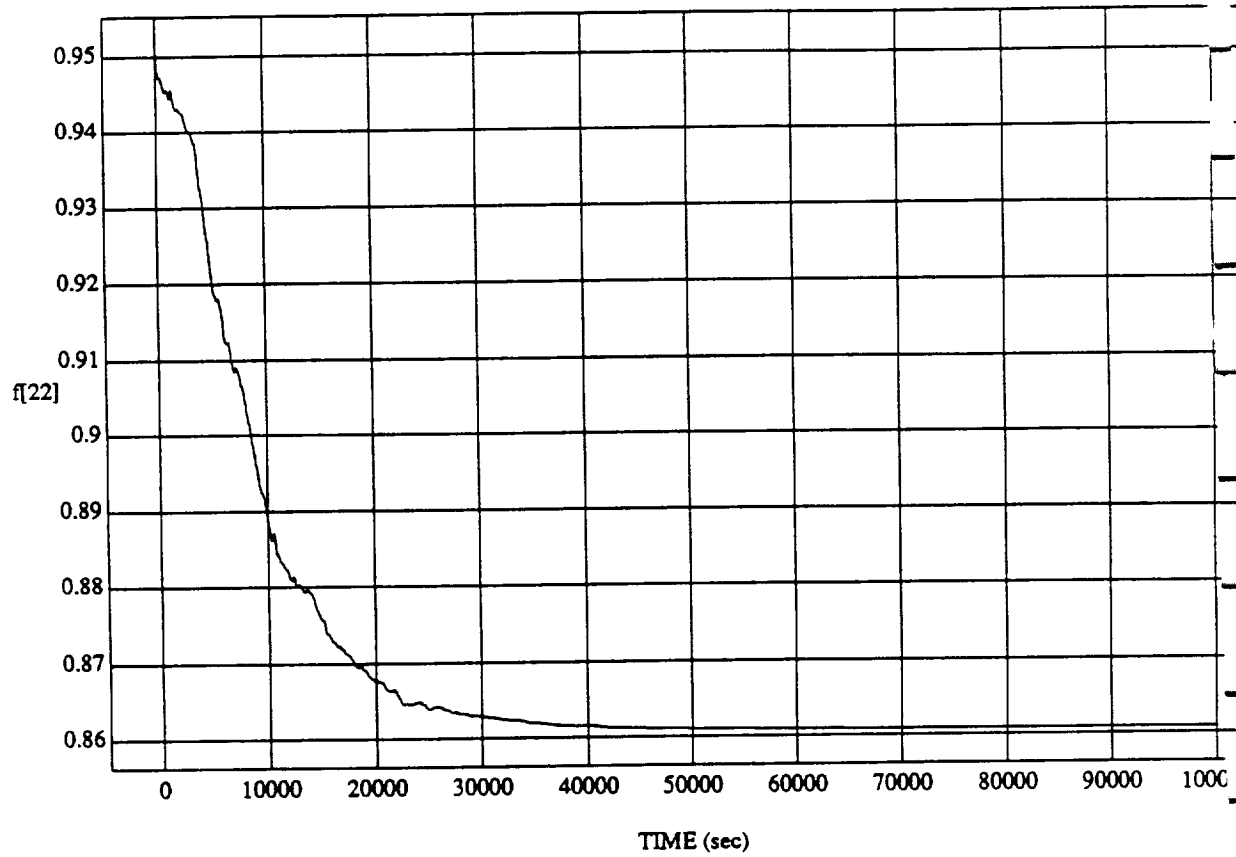


MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

f[22] vs TIME

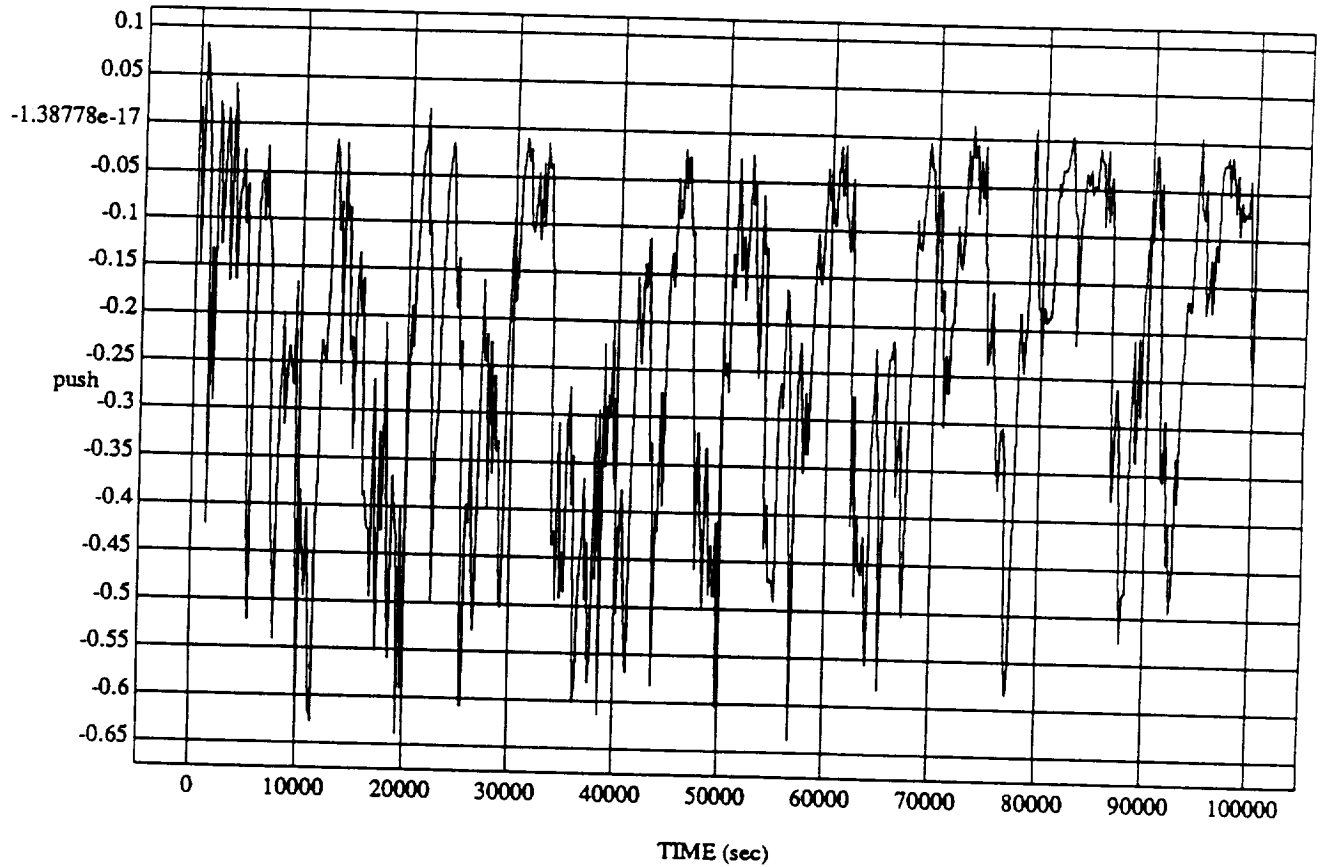
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

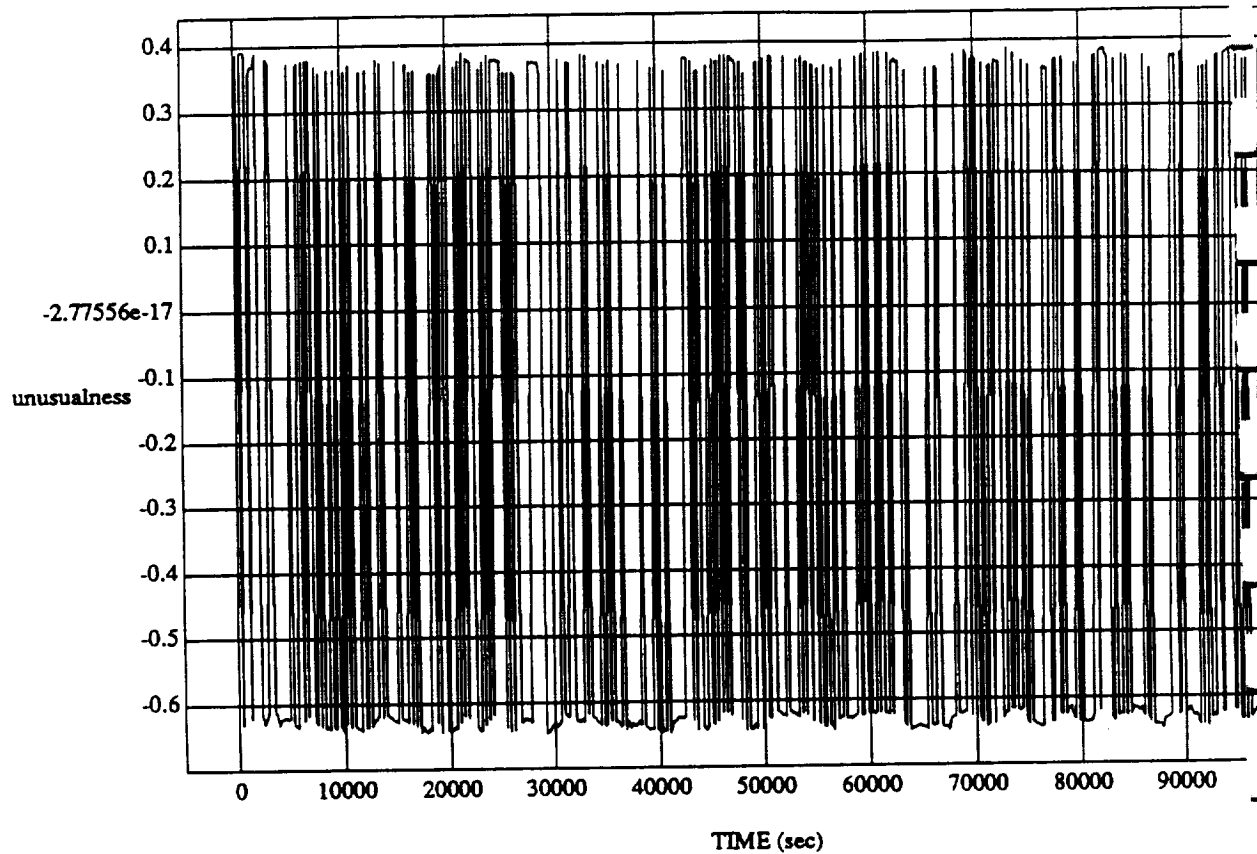
push vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lem2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

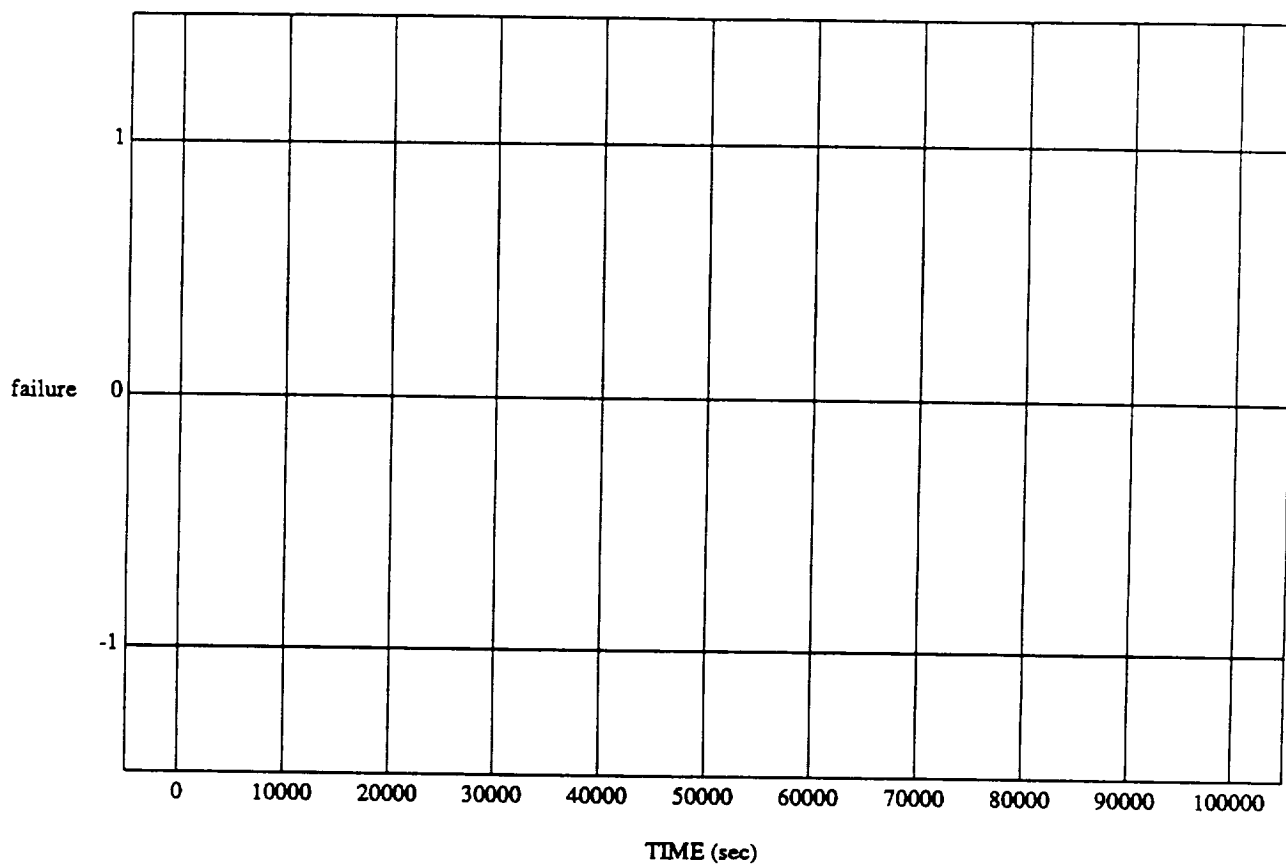
unusualness vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

failure vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

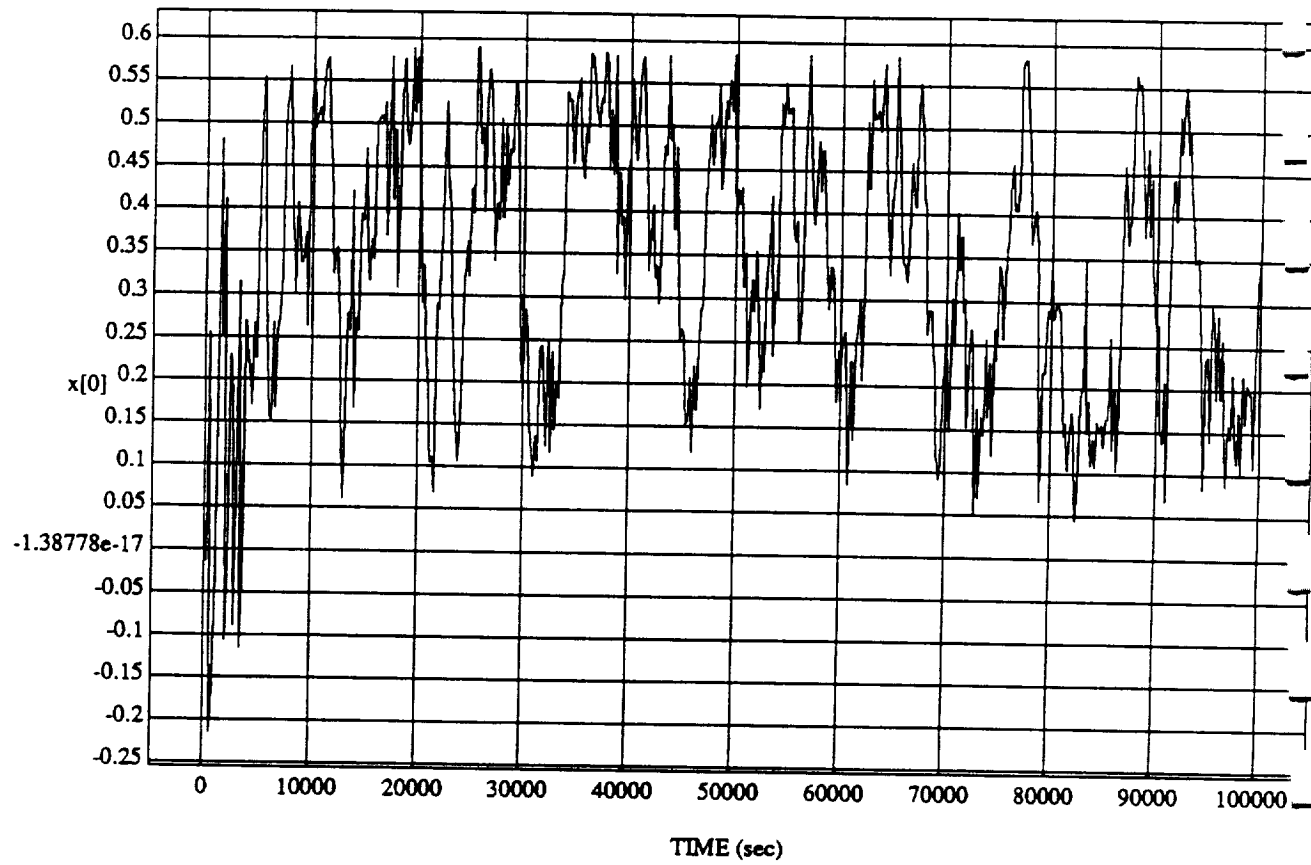


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$x[0]$  vs TIME

RUN: Weights Updated By Rule Strength - 2 July 1992

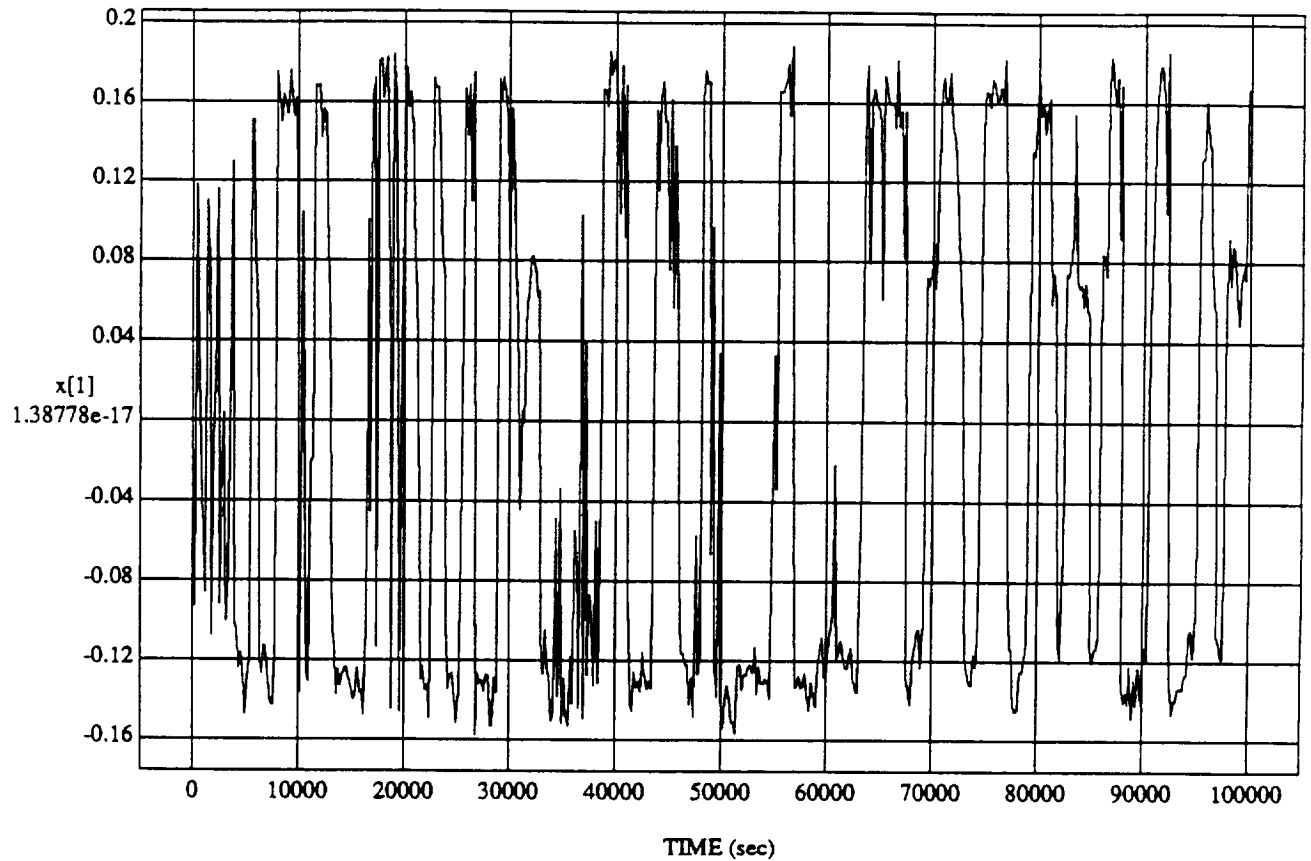


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$x[1]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

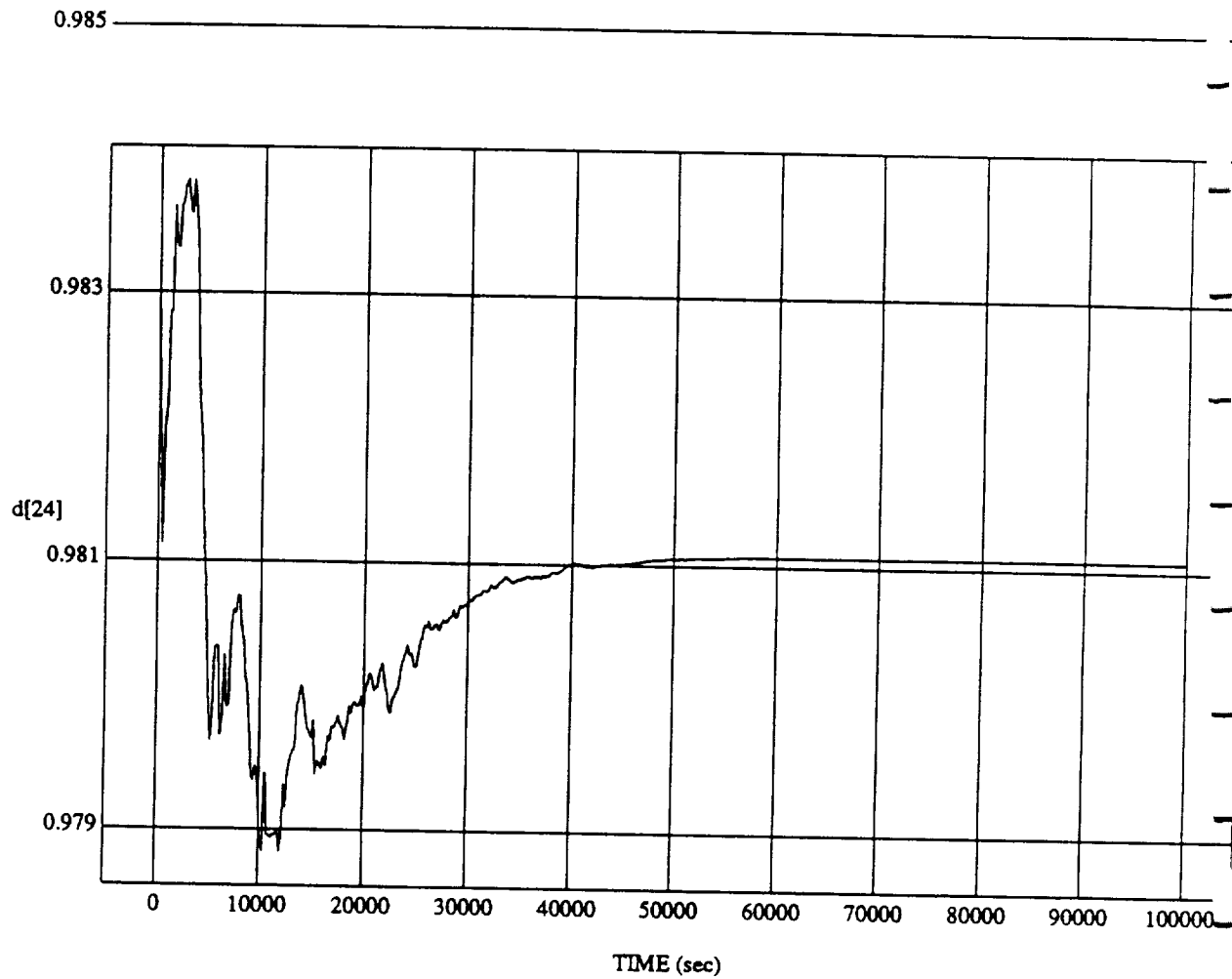


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[24] vs TIME

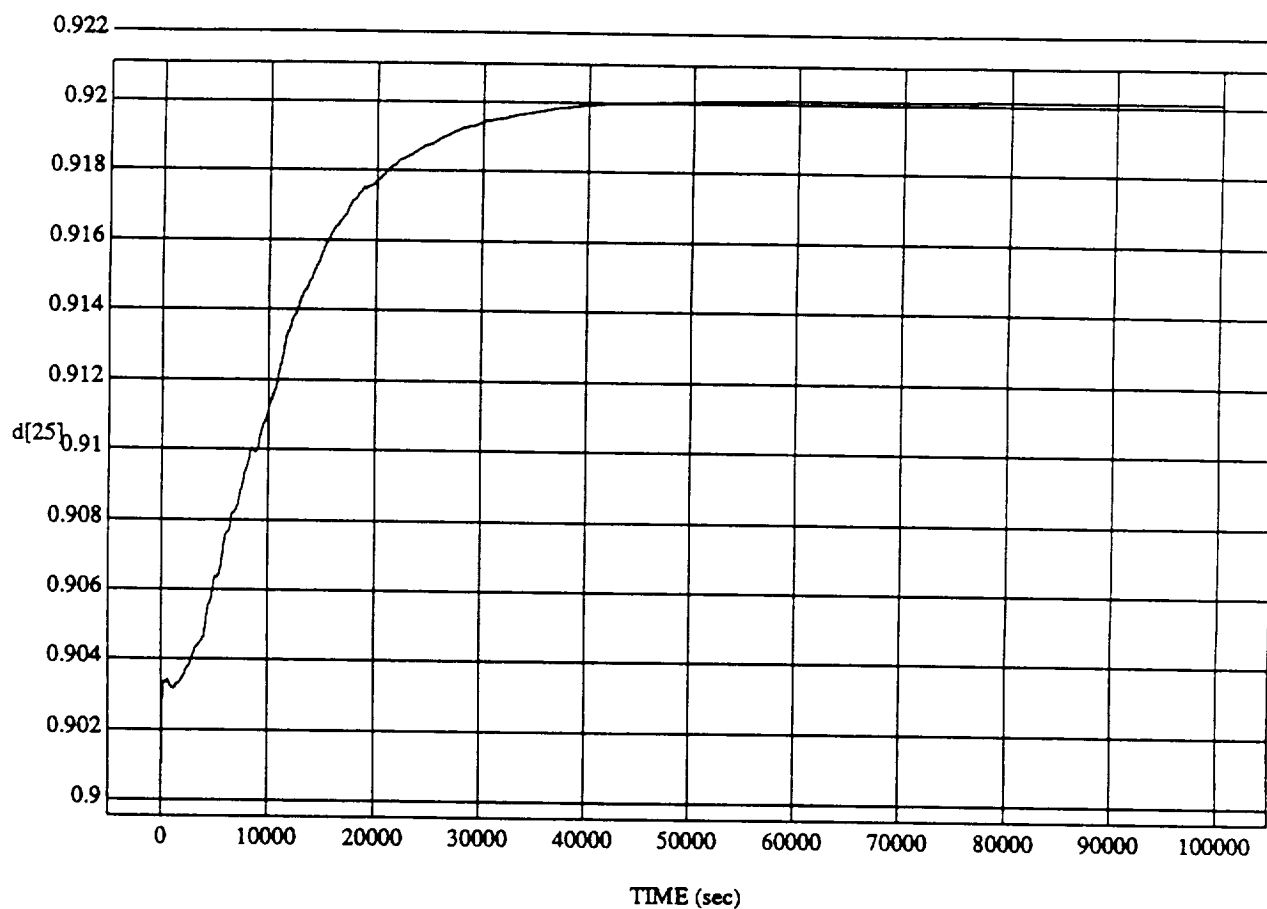
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

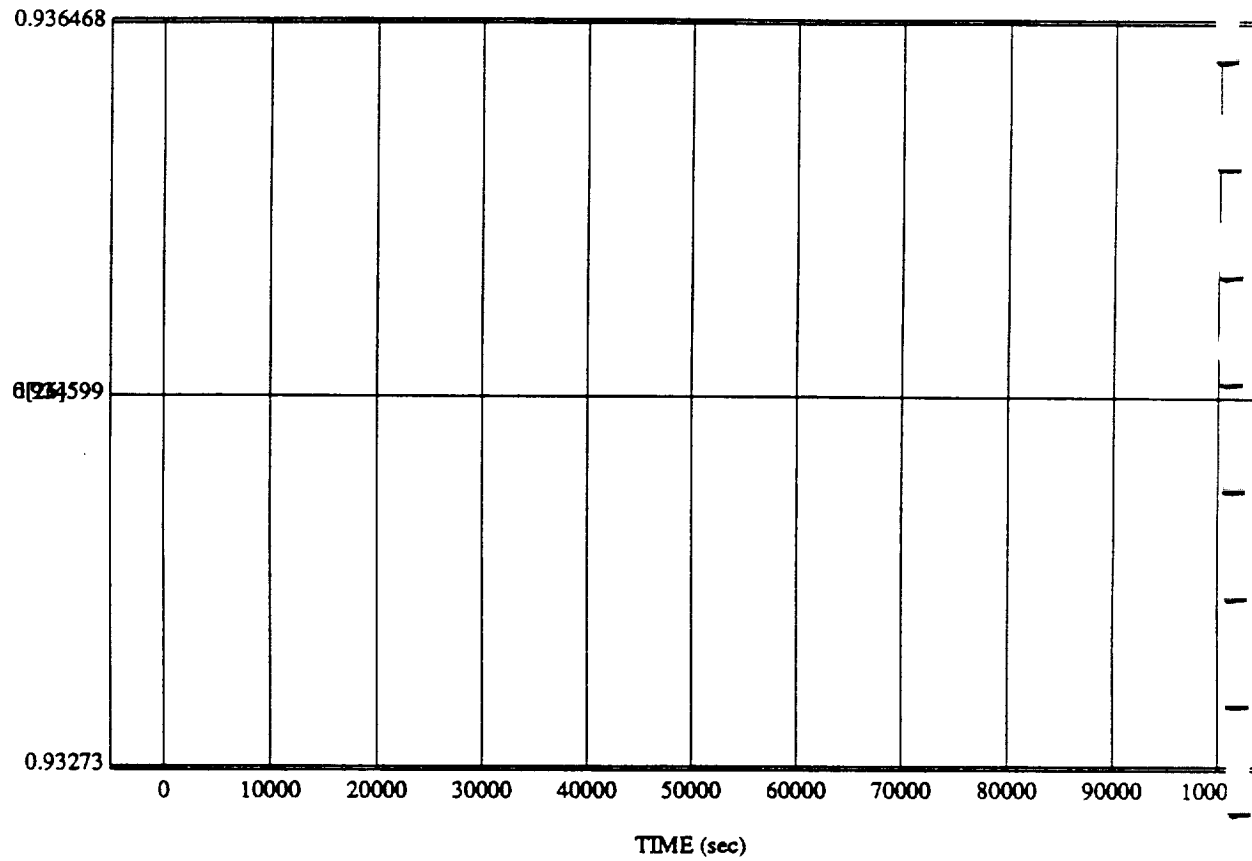
d[25] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.1cam2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

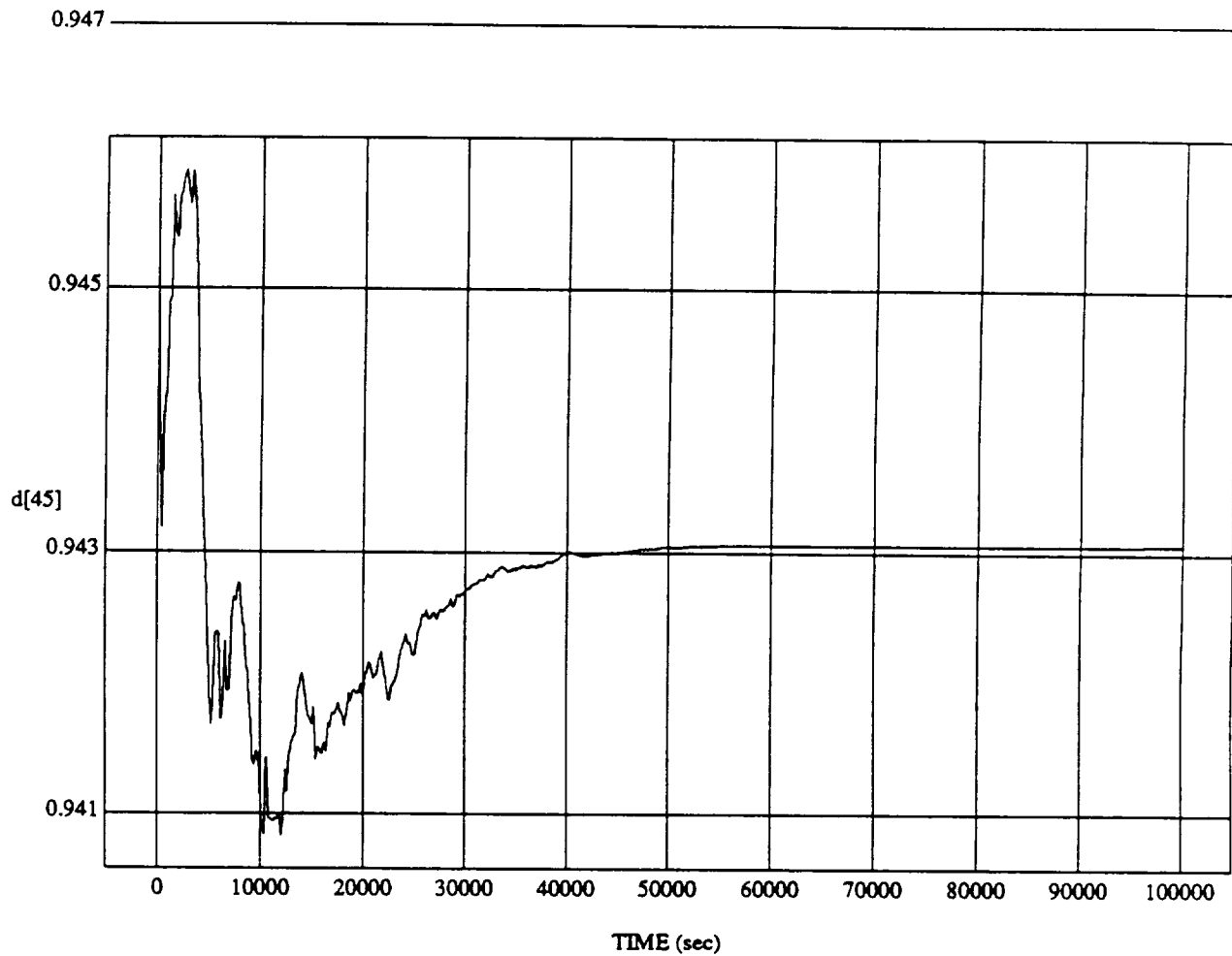
d[26] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

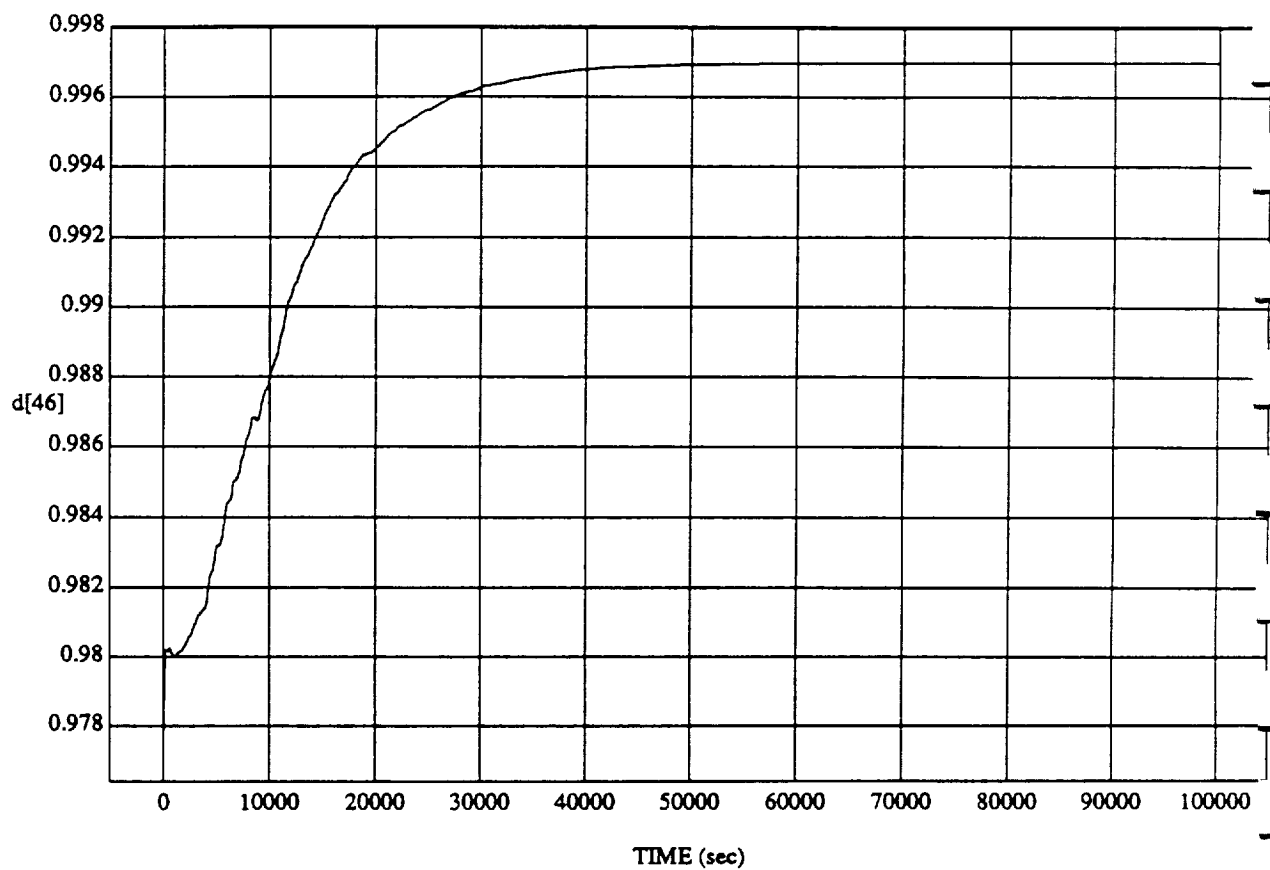
d[45] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

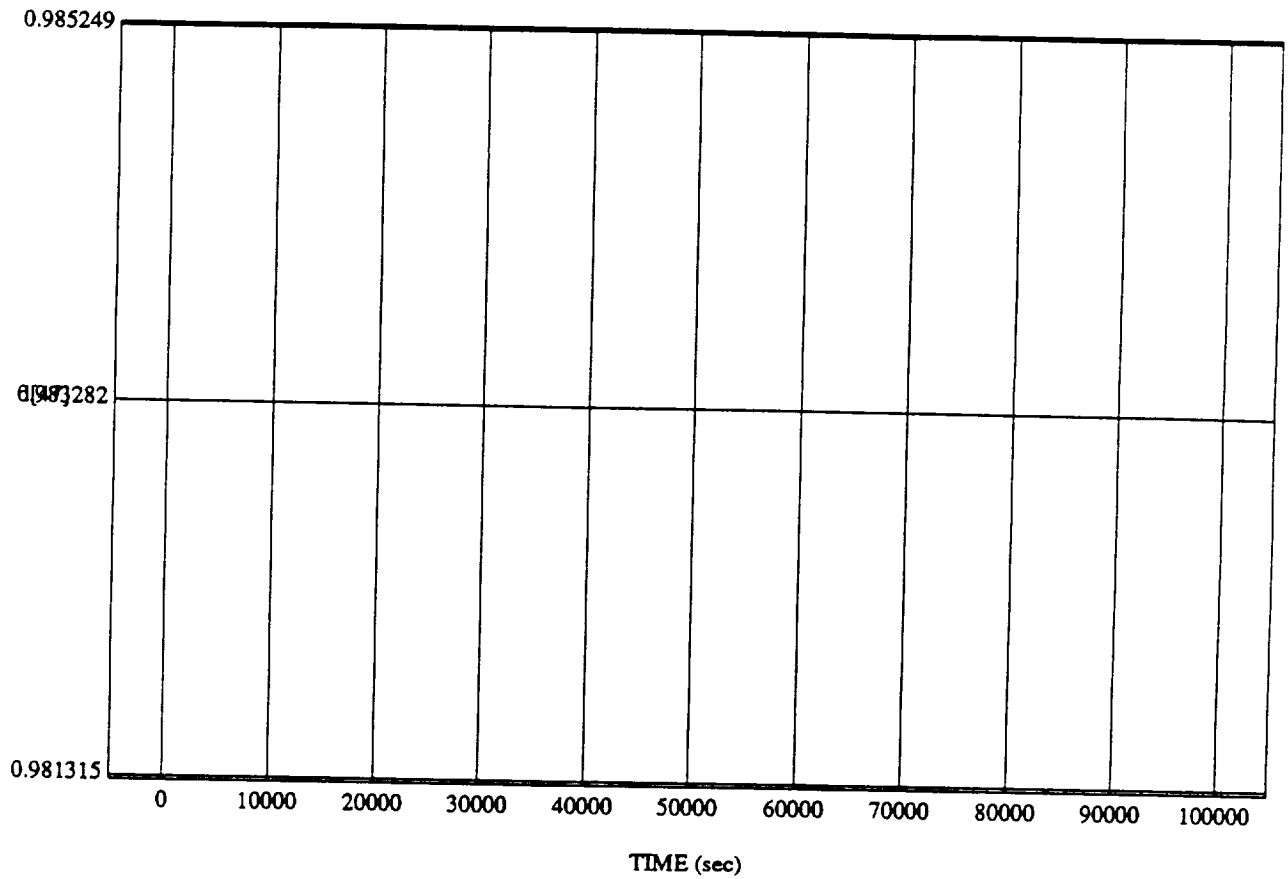
d[46] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

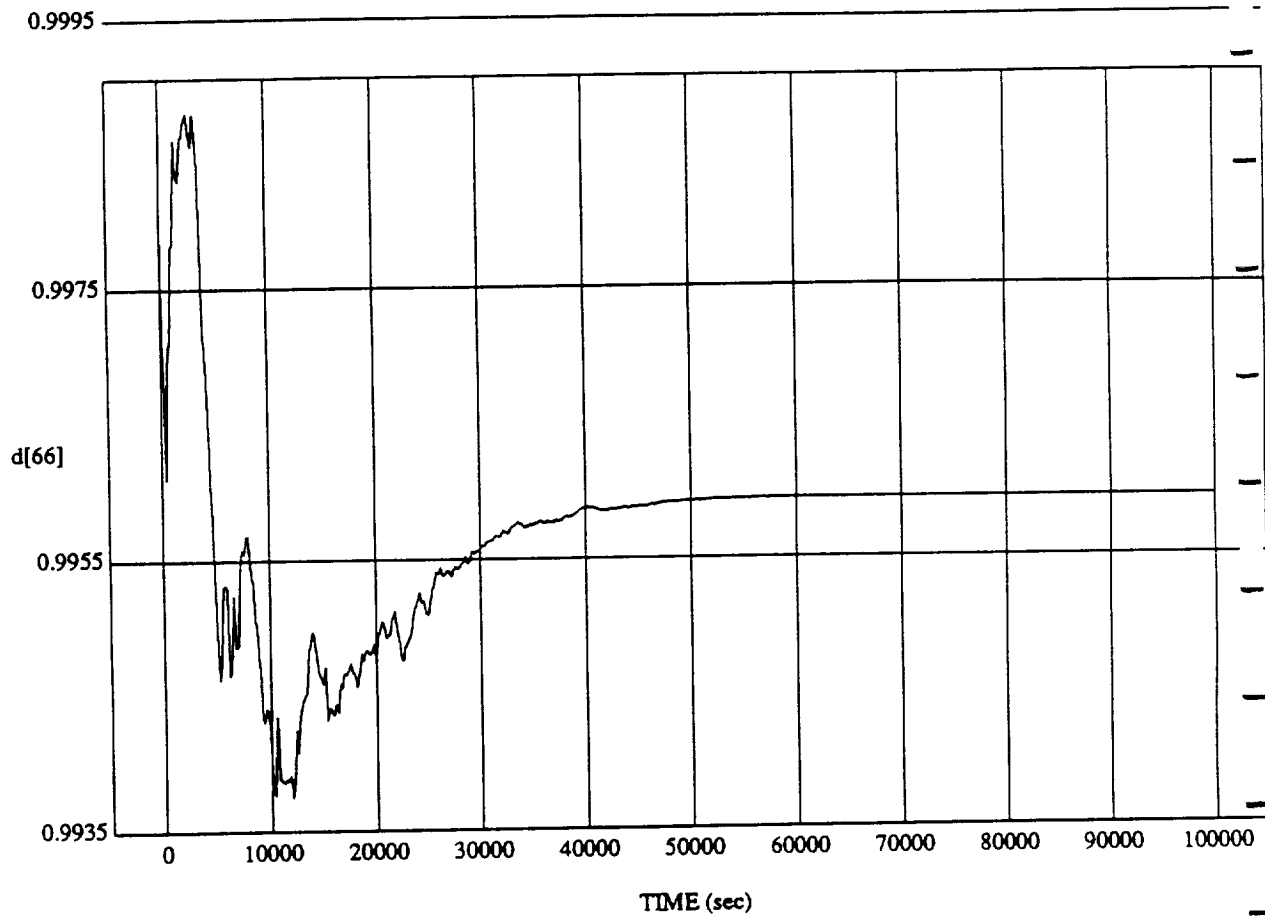
d[47] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCHLearn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[66] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

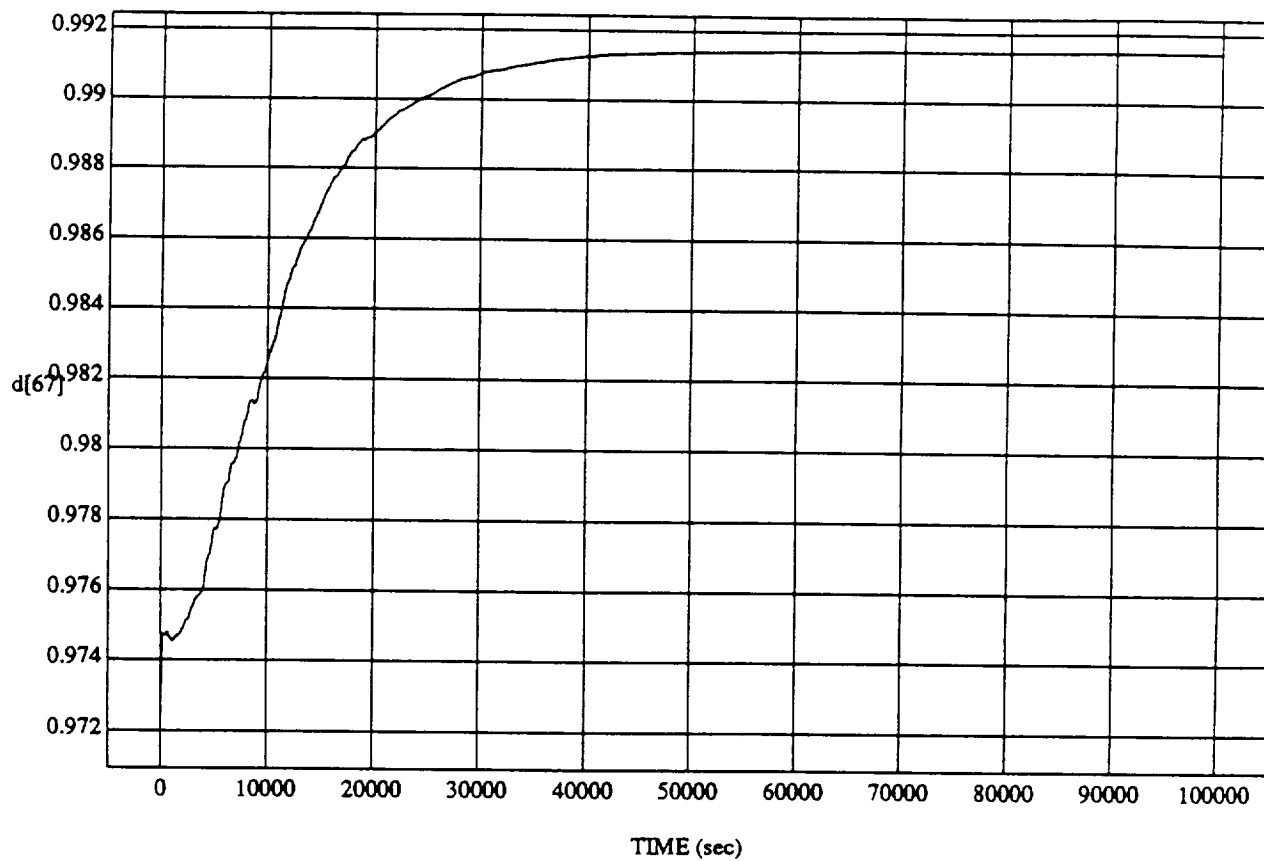


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[67] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

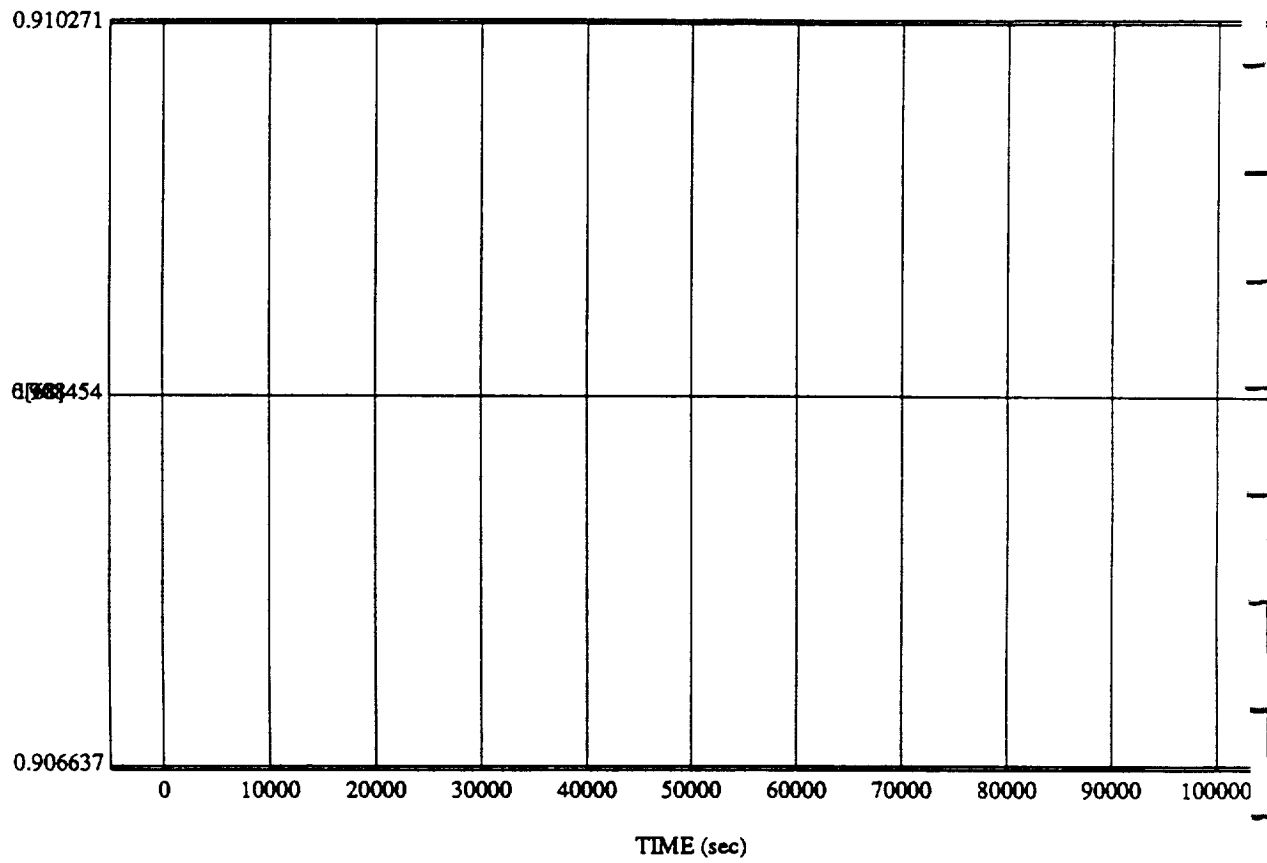


MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[68] vs TIME

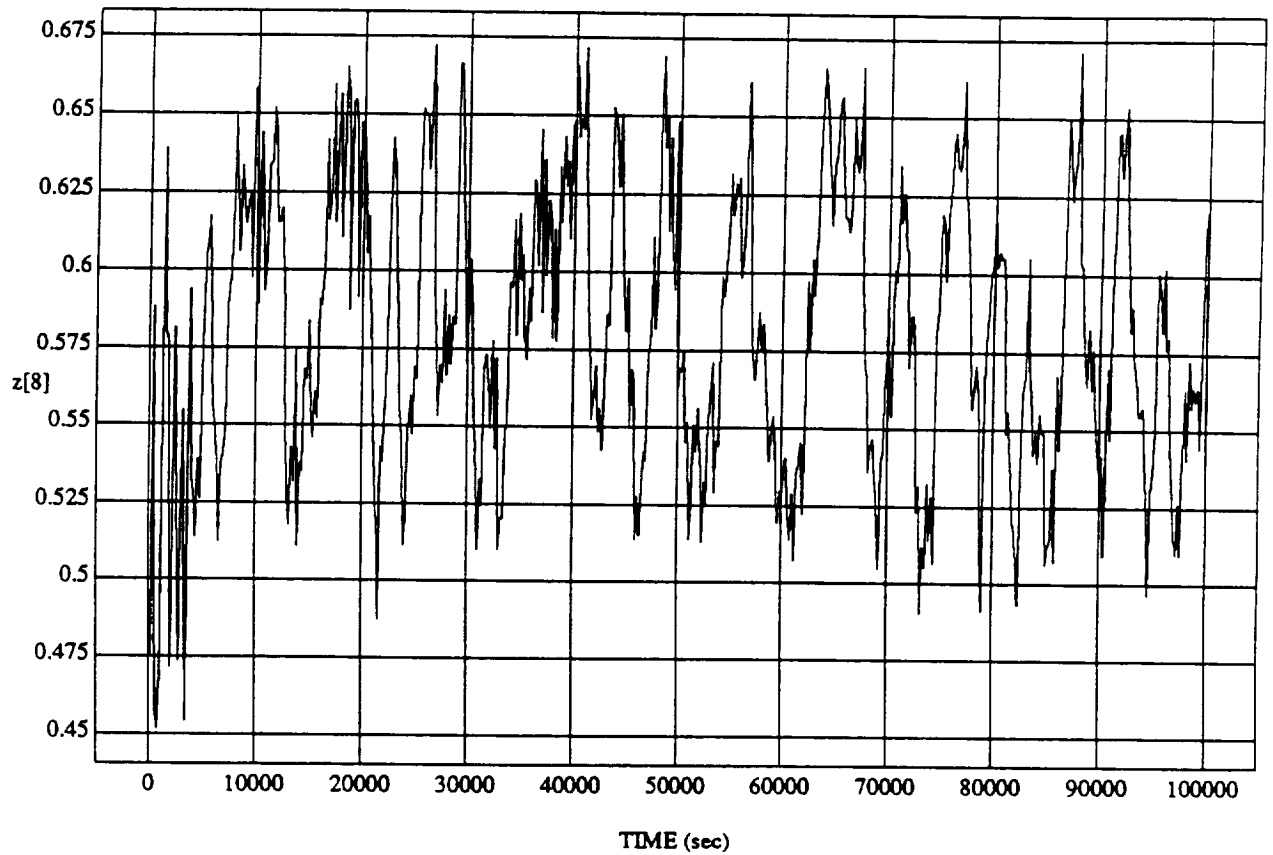
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

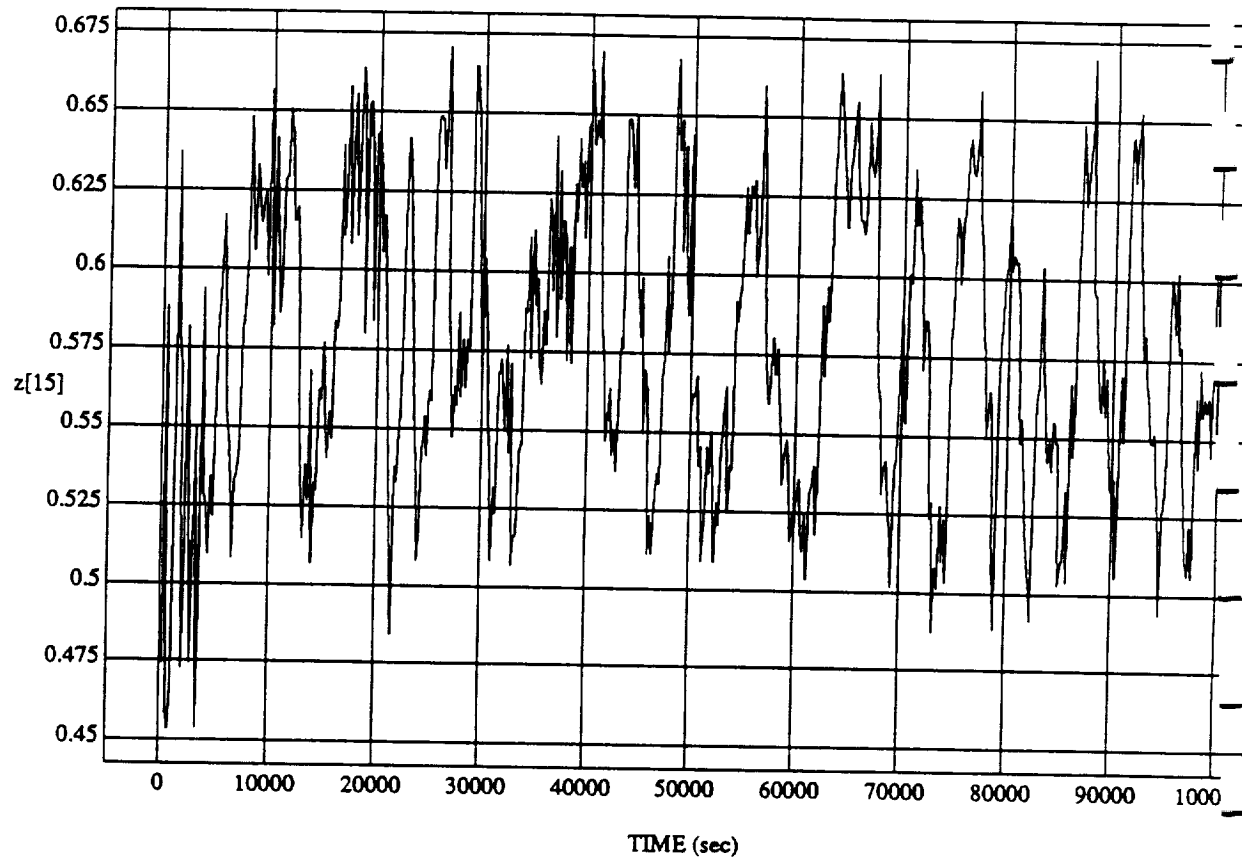
$z[8]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

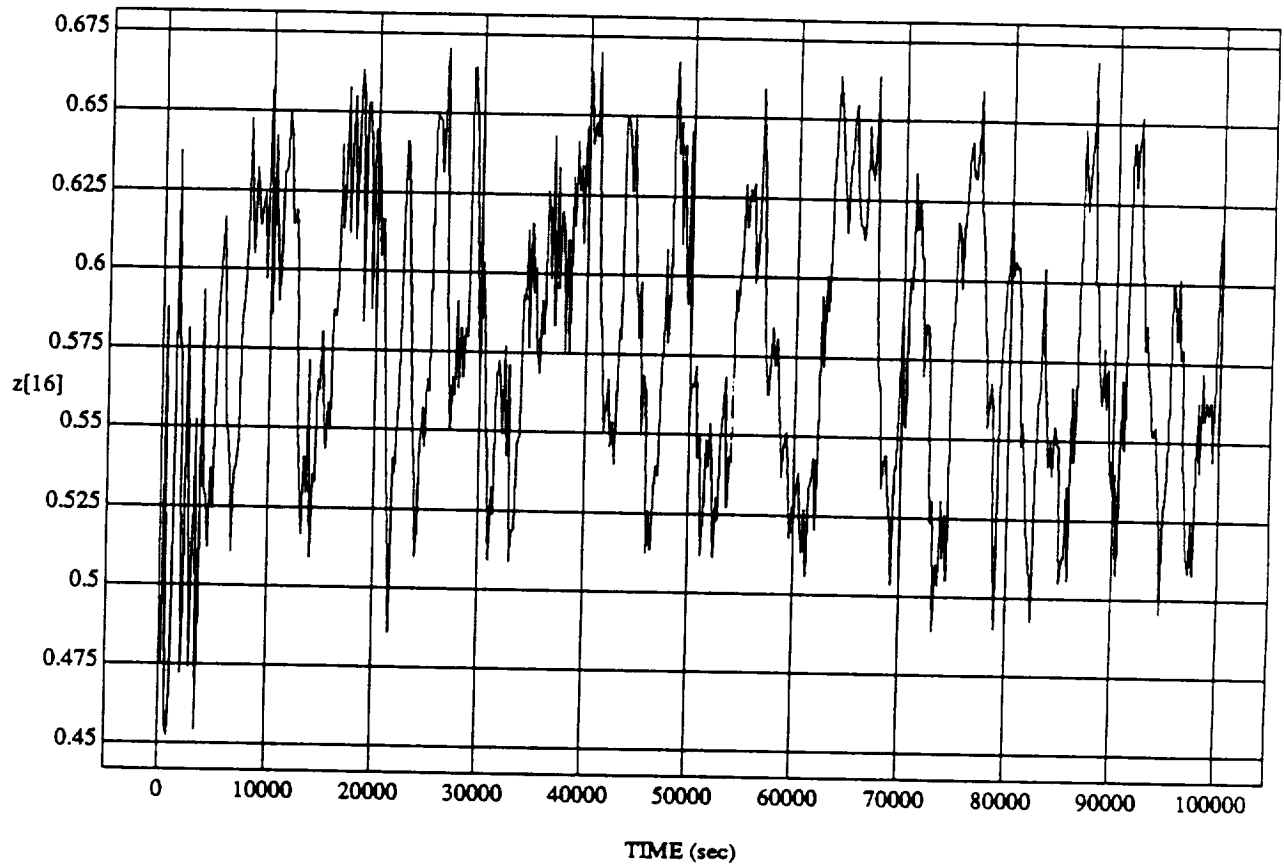
$z[15]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

$z[16]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

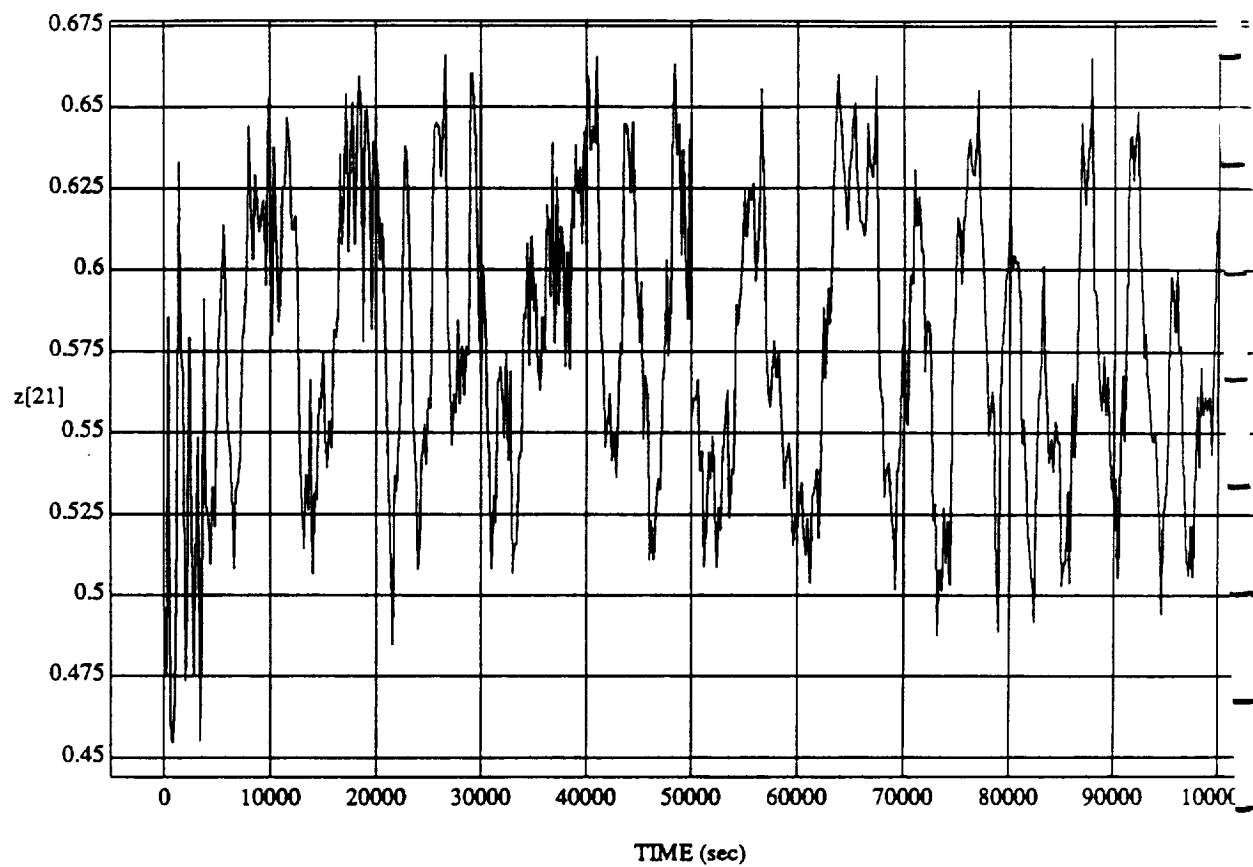


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

z[21] vs TIME

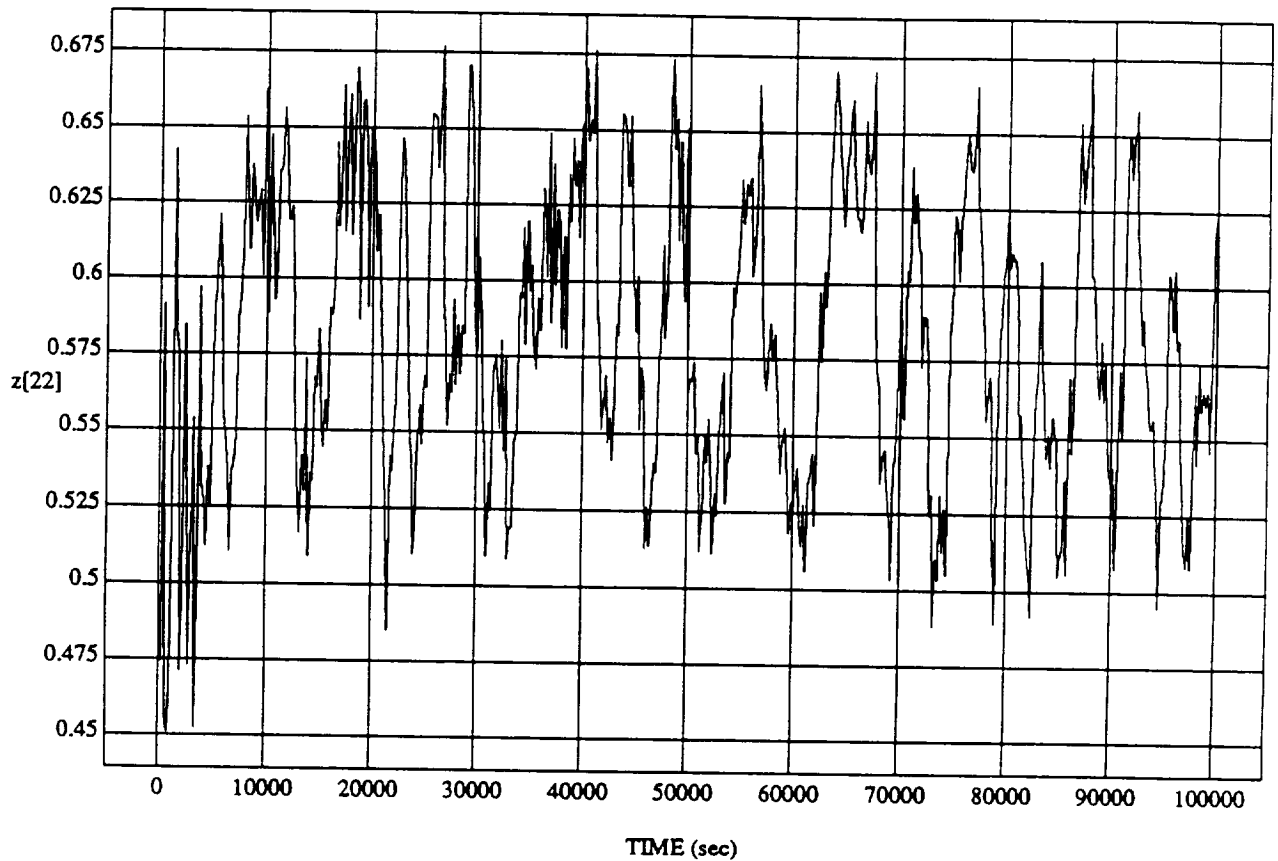
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

z[22] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz







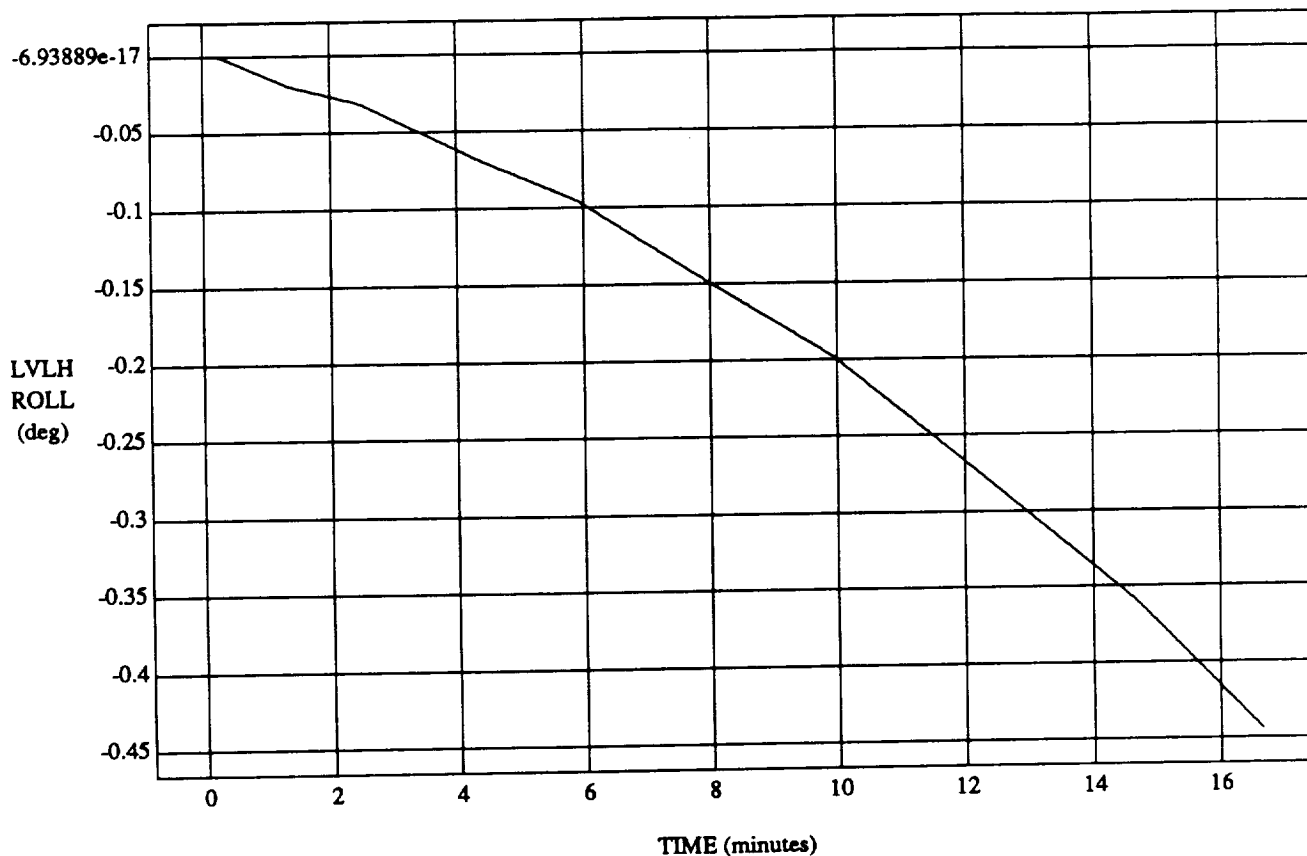


SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

*XIV*

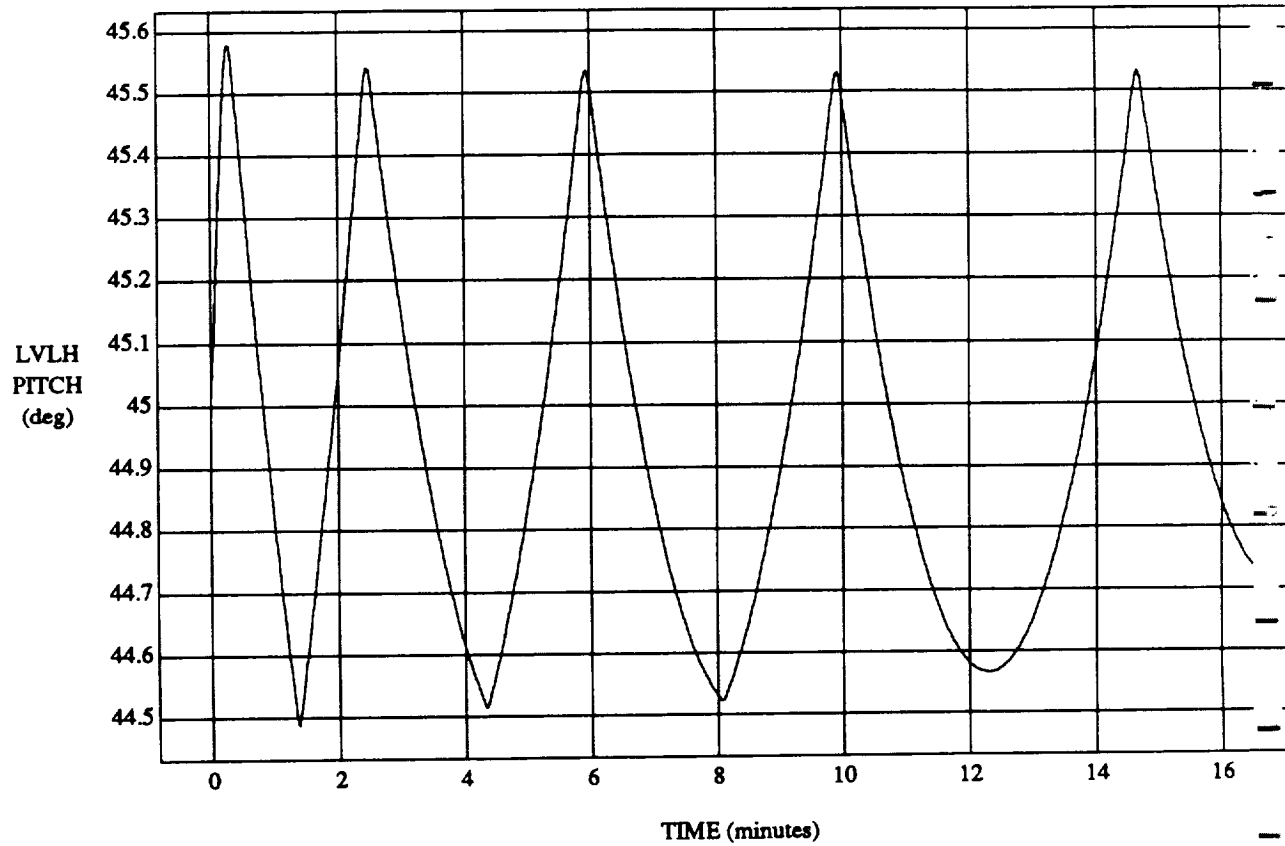
*D's updated*  
*h, w, c*

**LVLH EULER PYR ROLL vs TIME**  
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

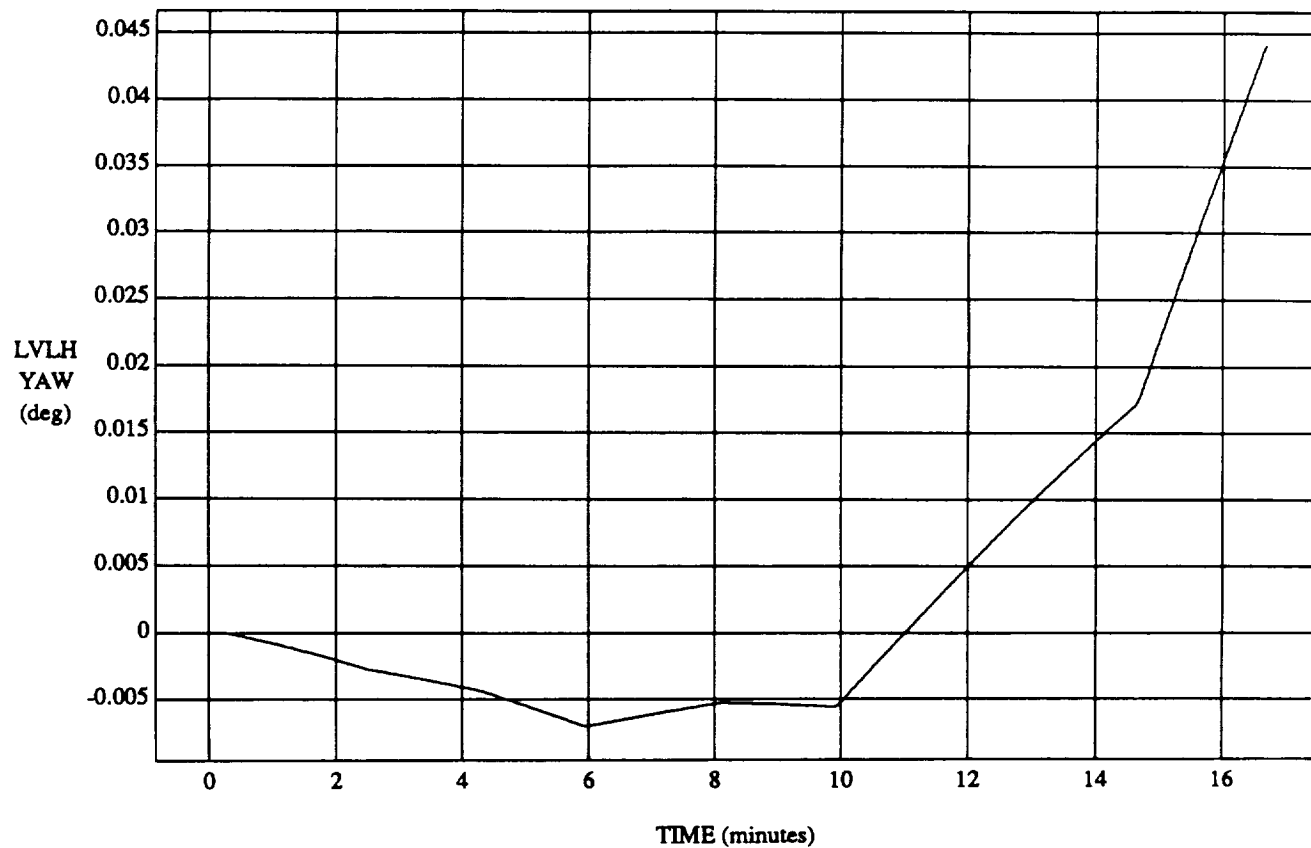
**LVLH EULER PYR PITCH vs TIME**  
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

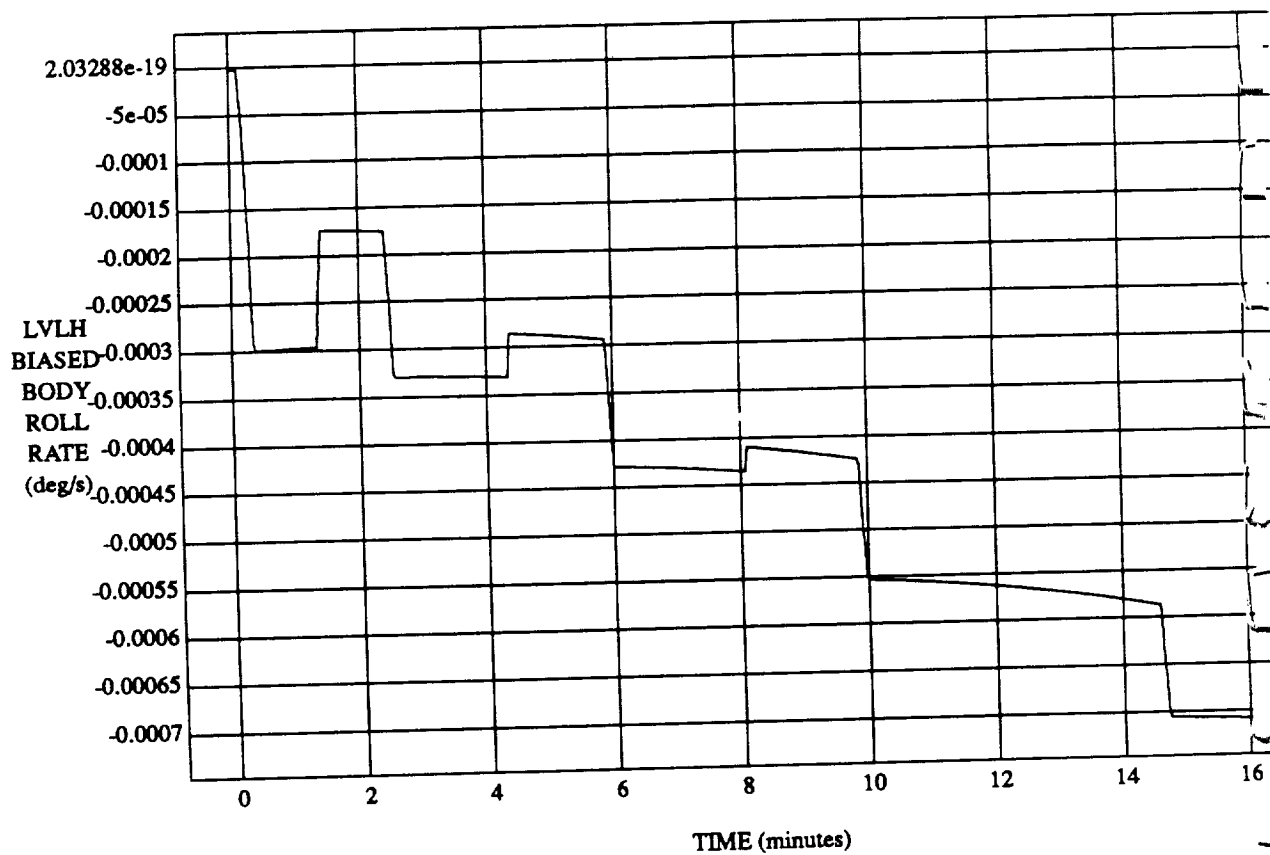
LVLH EULER PYR YAW vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

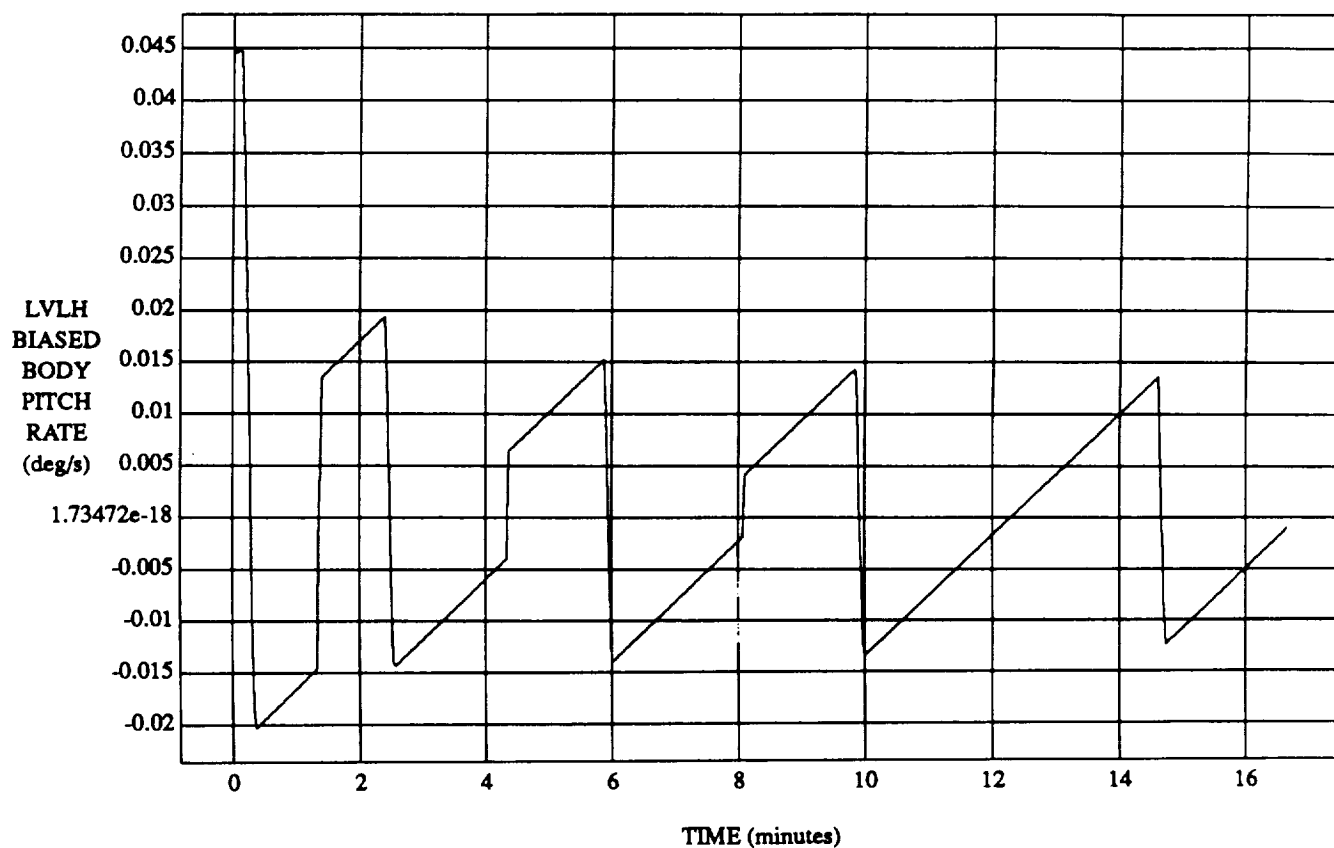
LVLH BIASED BODY ROLL RATE vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

### LVLH BIASED BODY PITCH RATE vs TIME

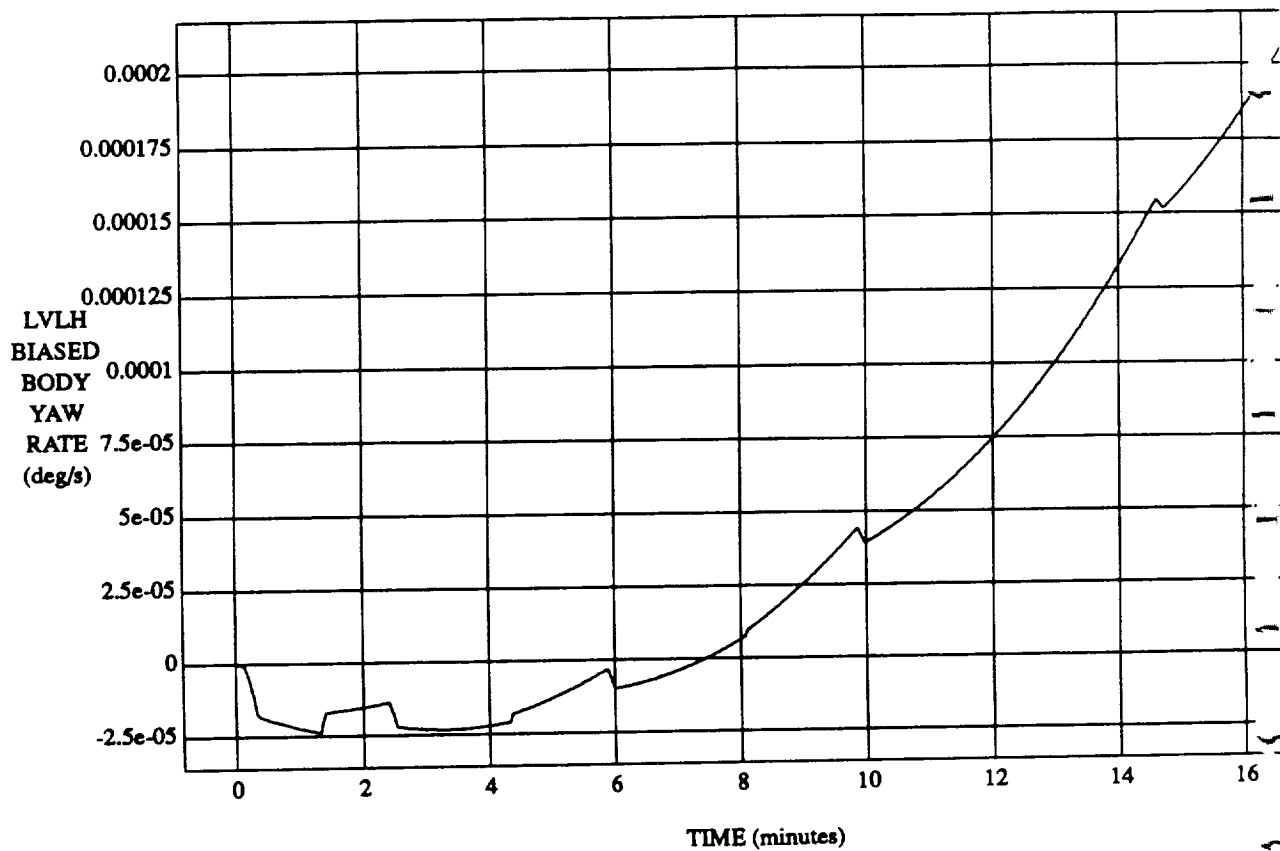
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz

### LVLH BIASED BODY YAW RATE vs TIME

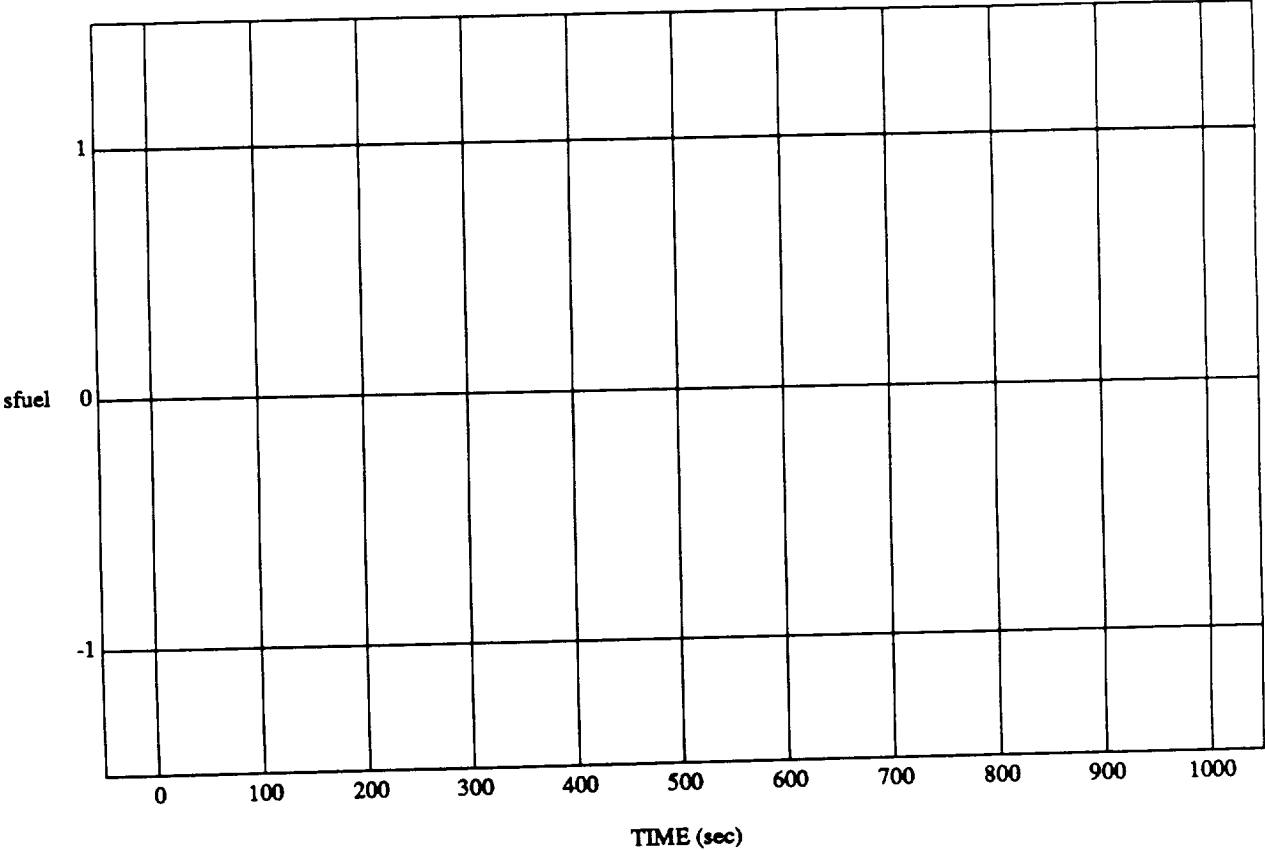
RUN: Weights Updated By Rule Strength - 2 July 1992



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.500 Hz



sfuel vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

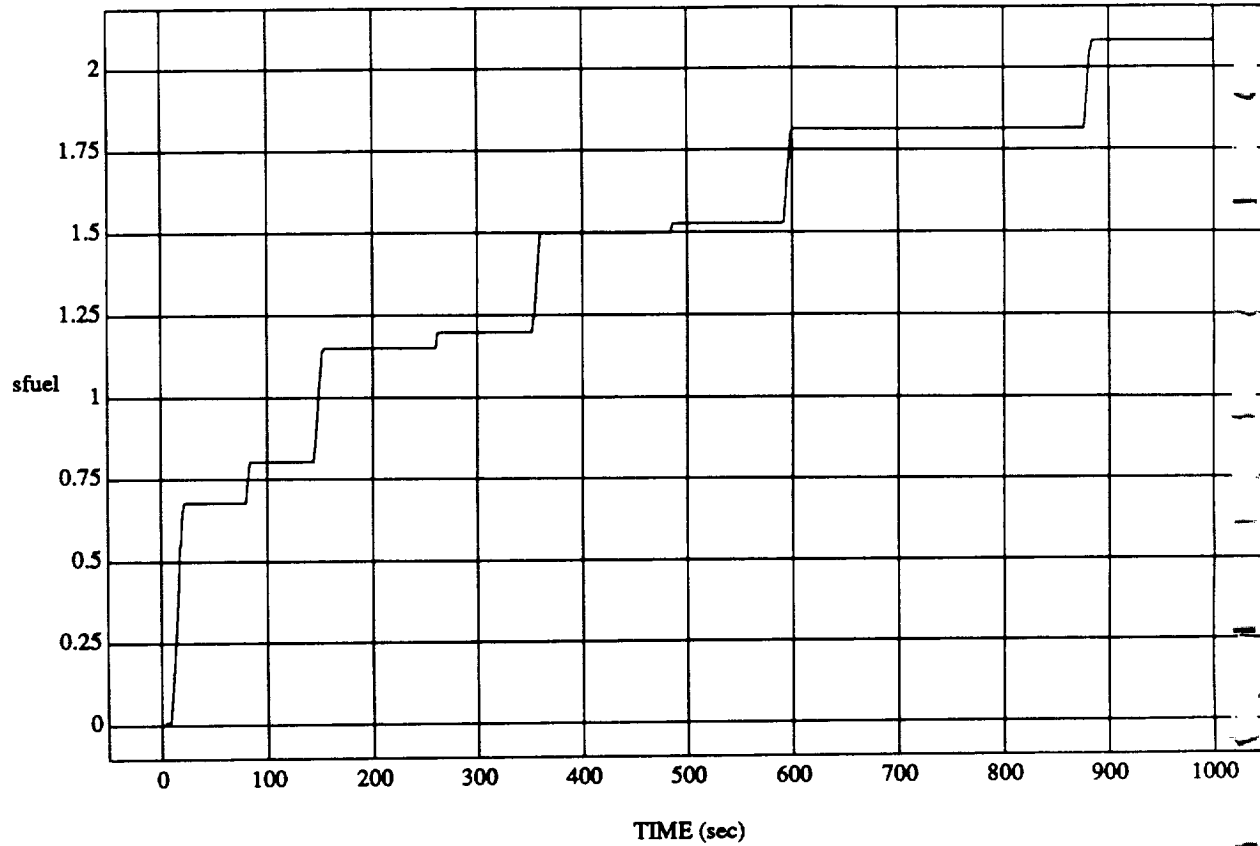


MODULE: ORB\_FUZZ\_BATCH.primary  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

sfuel vs TIME

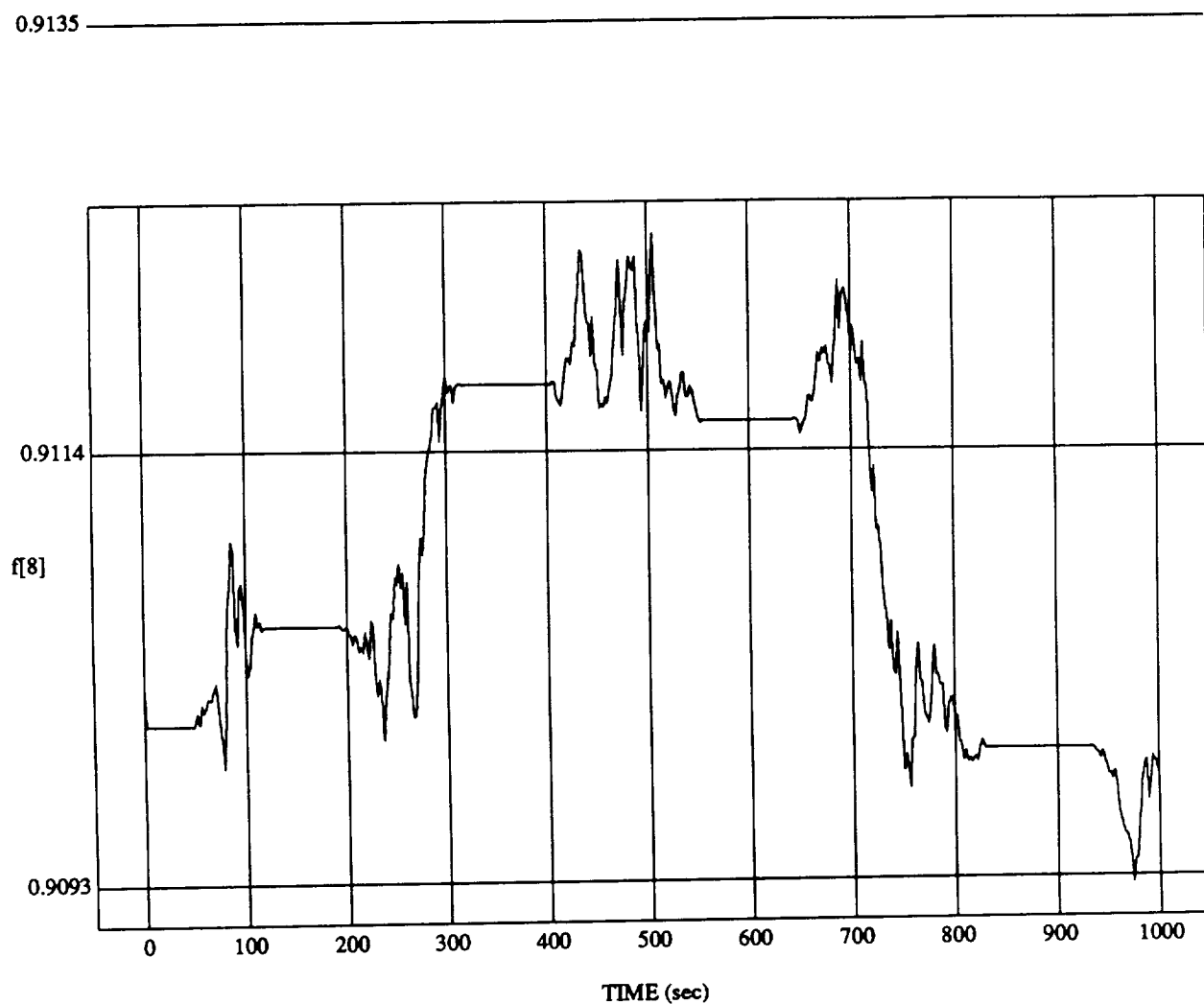
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

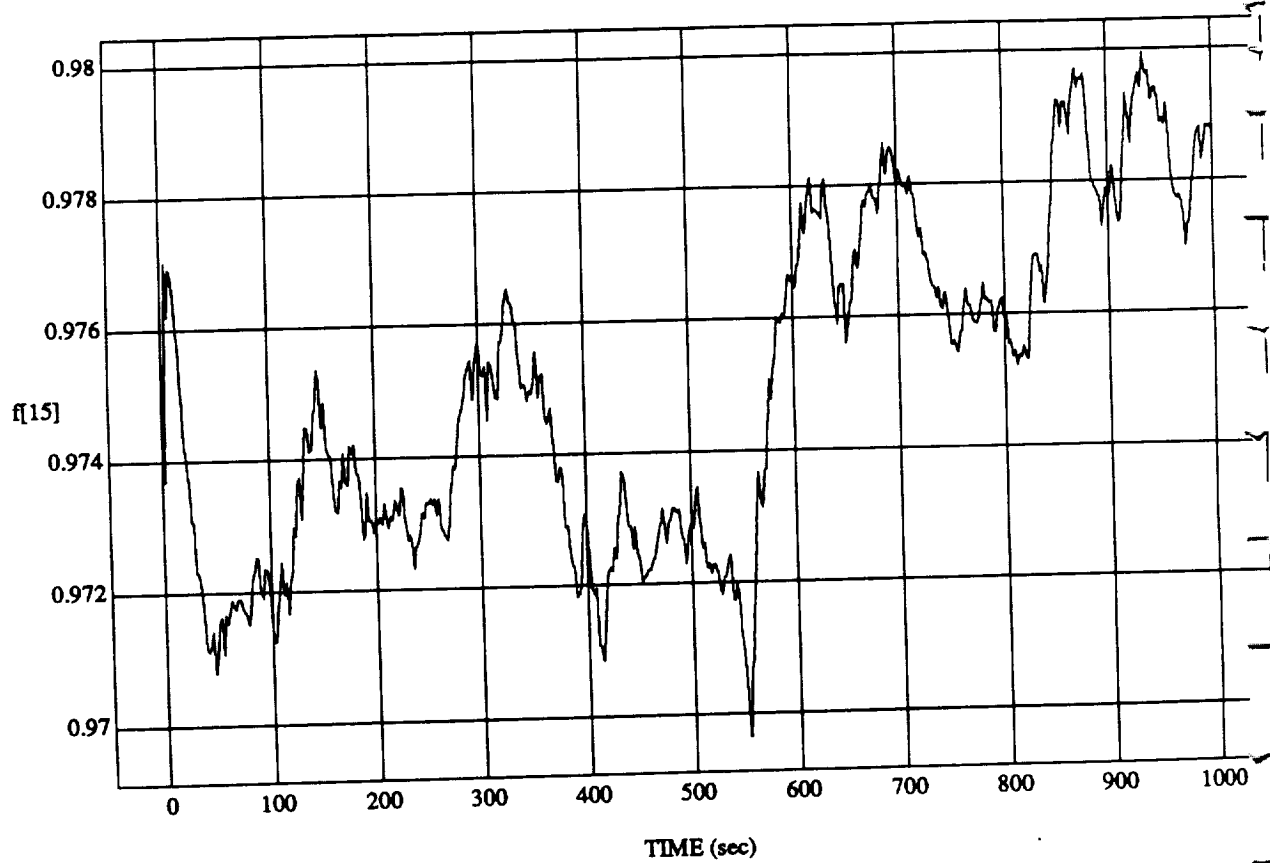
$f[8]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

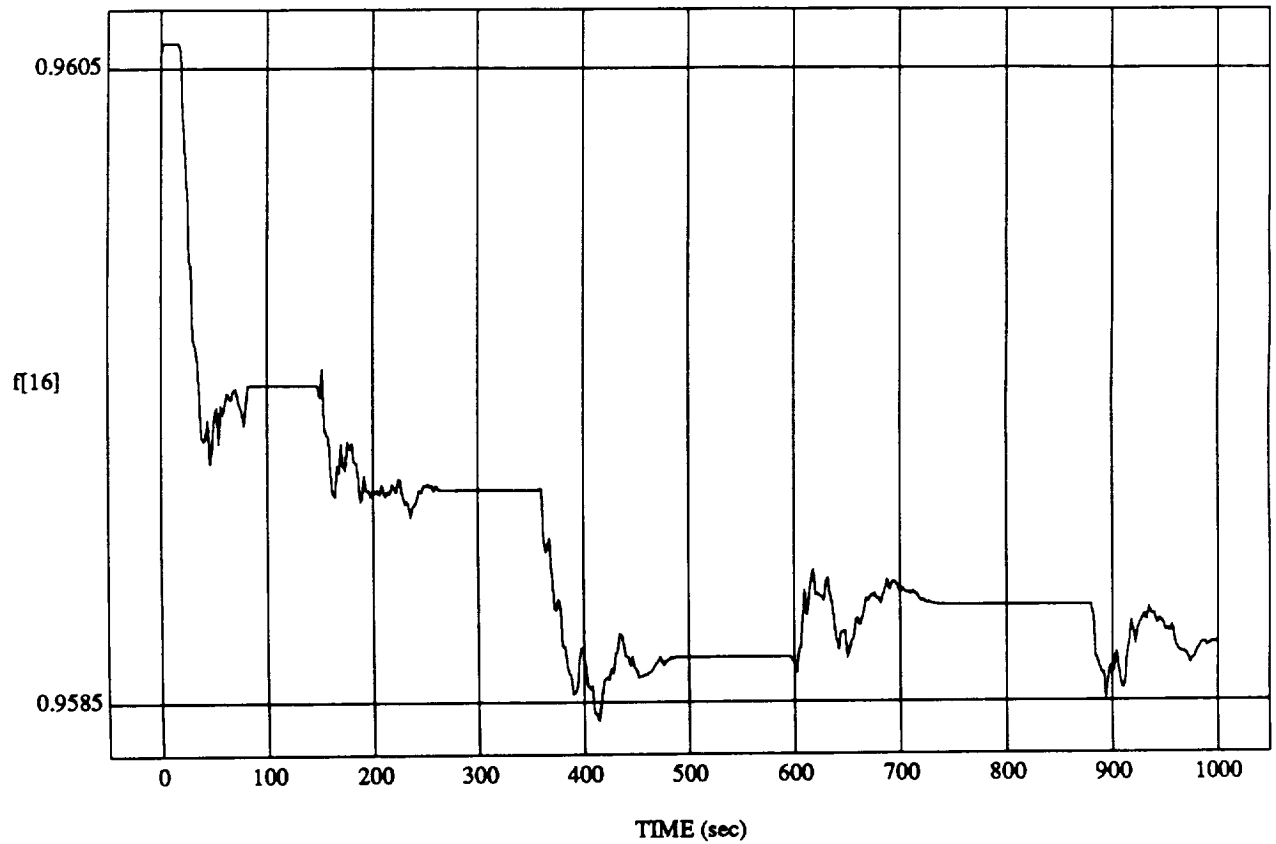
$f[15]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

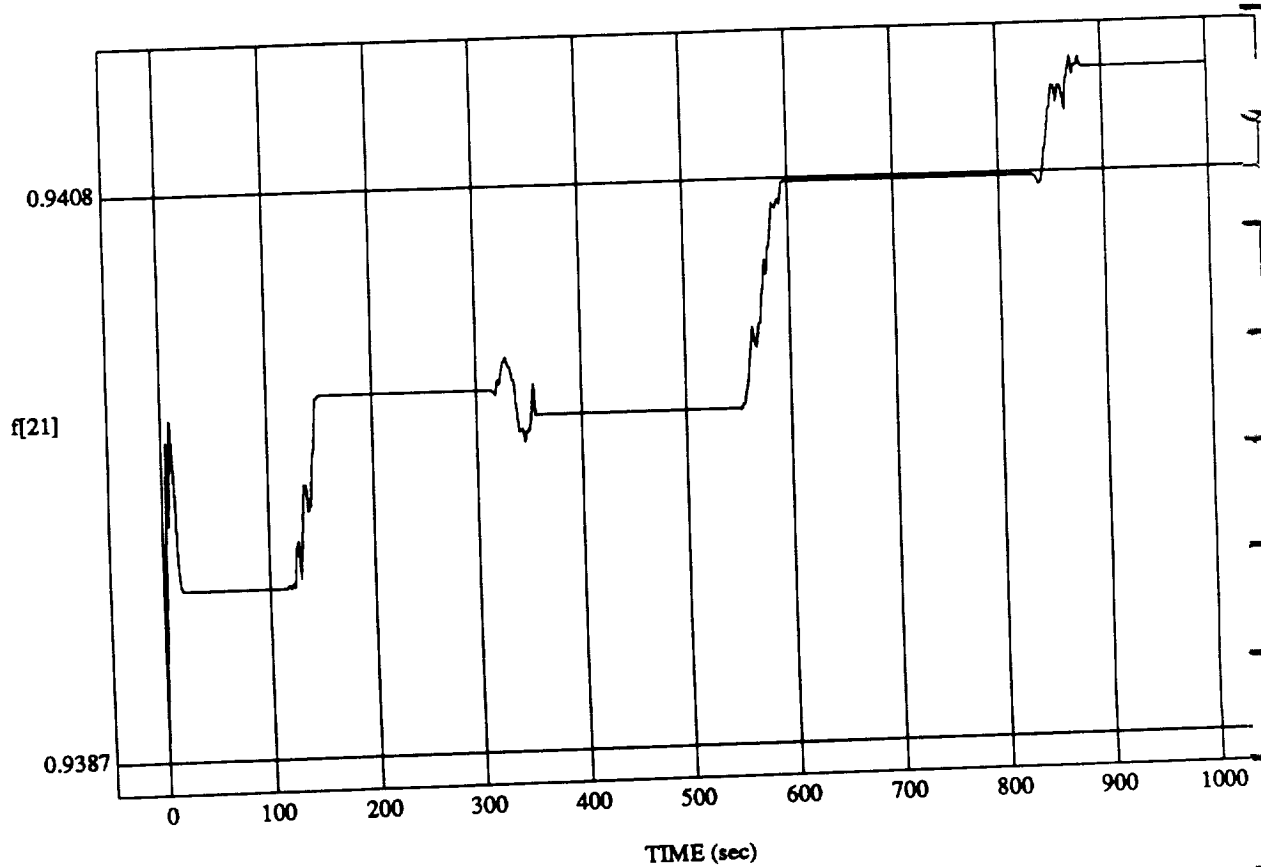
$f[16]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

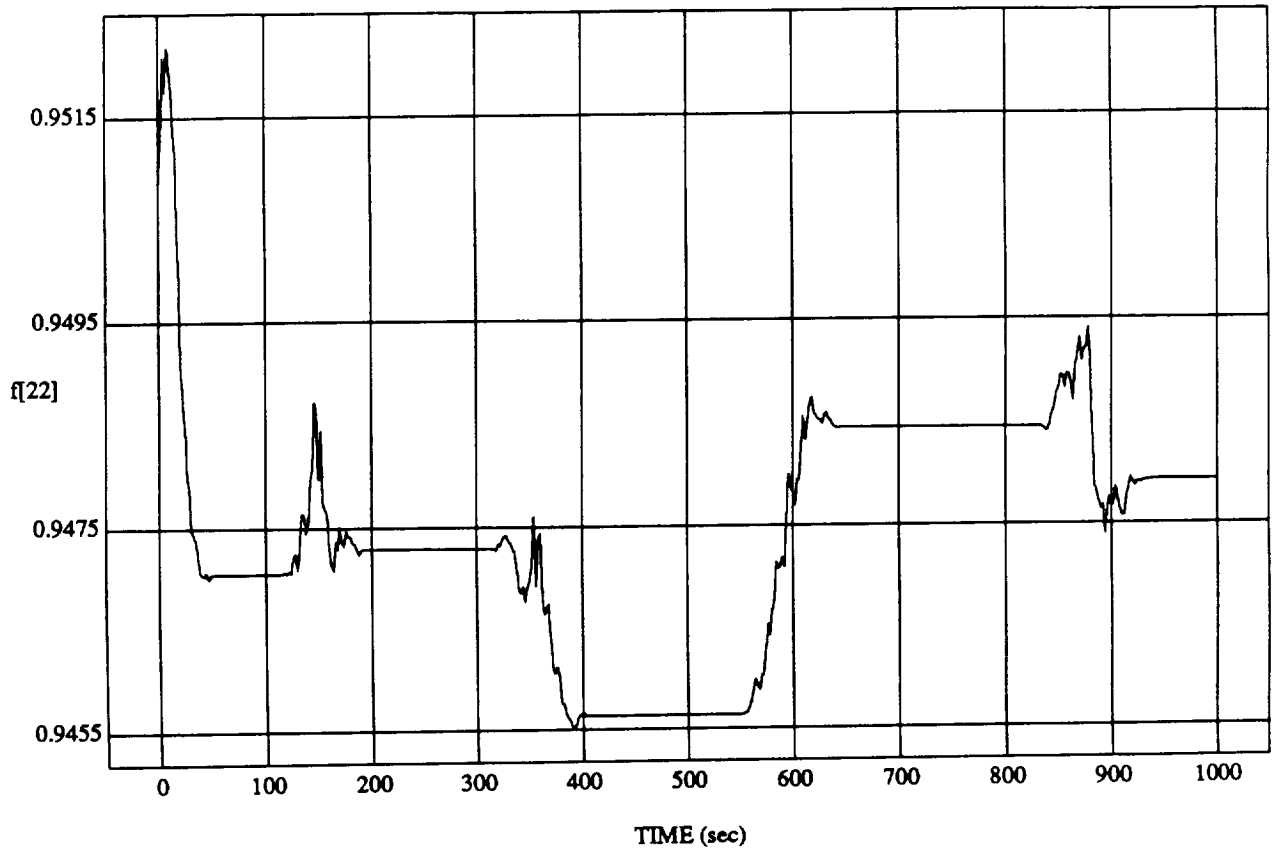
f[21] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

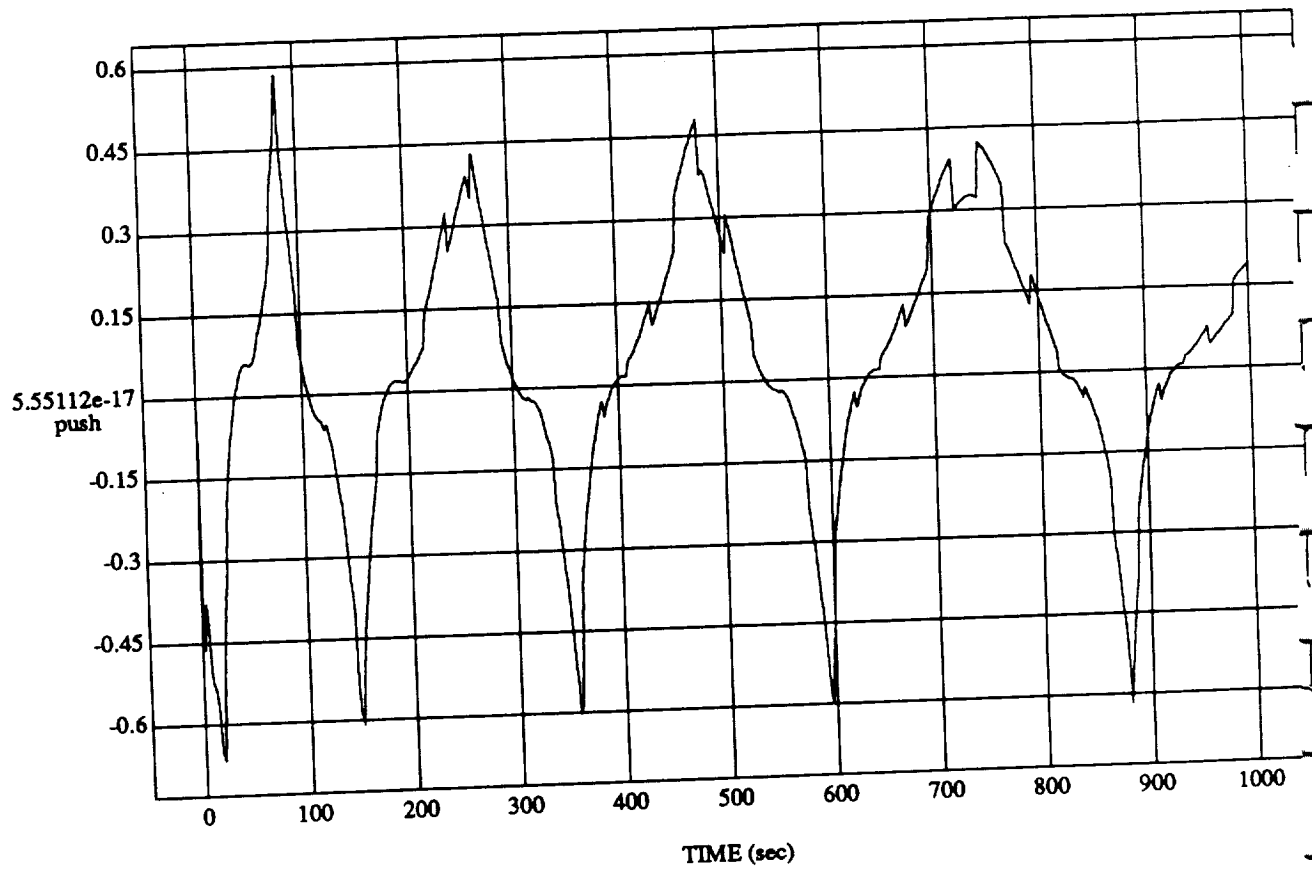
$f[22]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

push vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

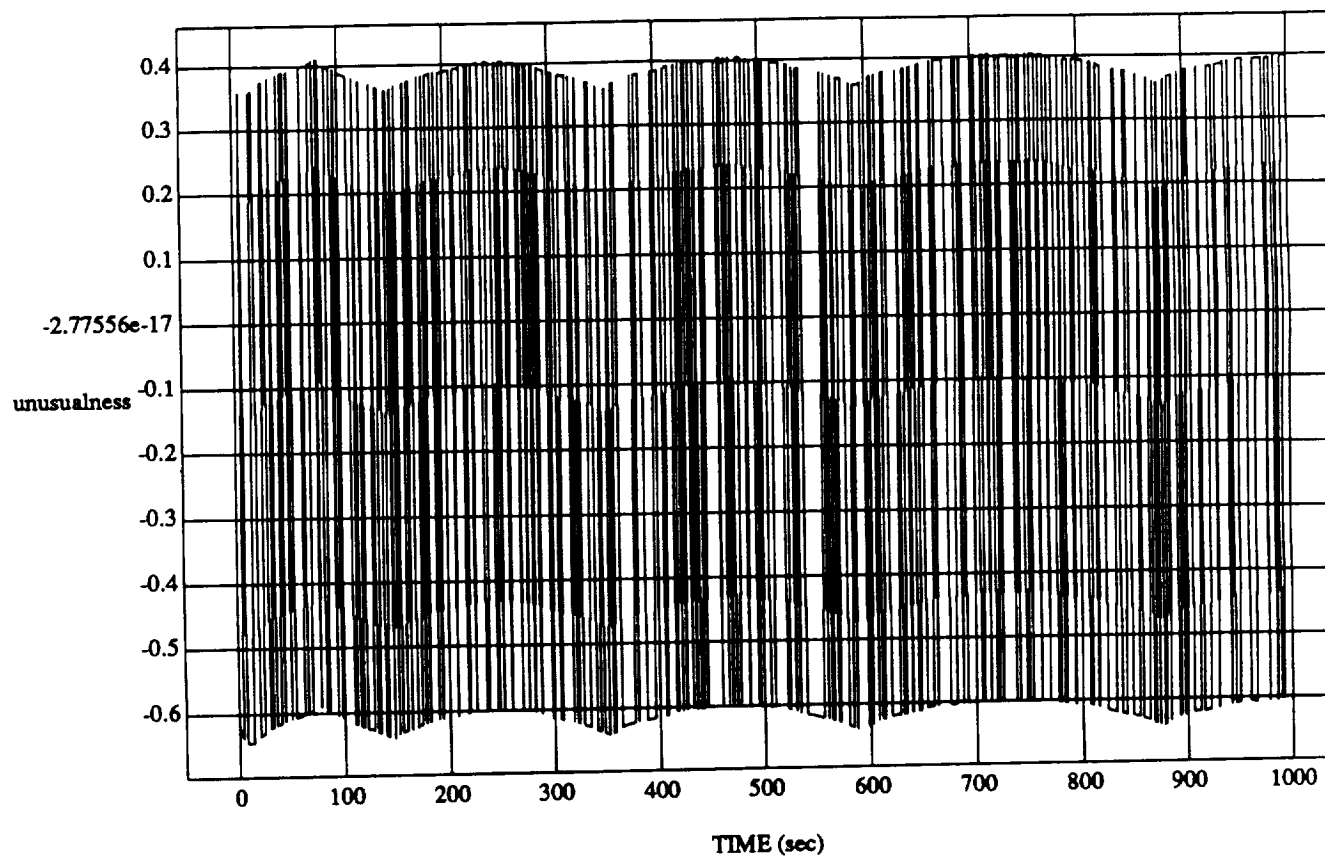


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

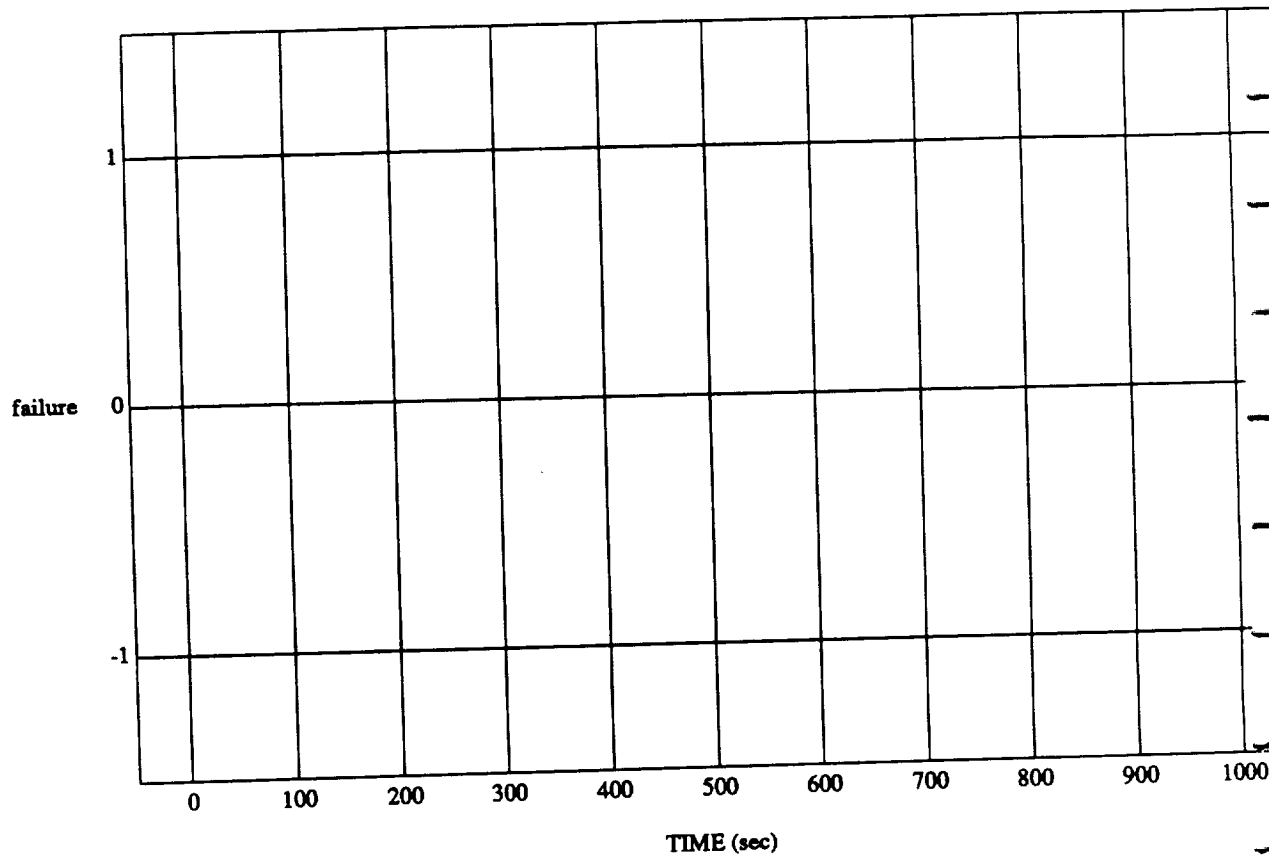
unusualness vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

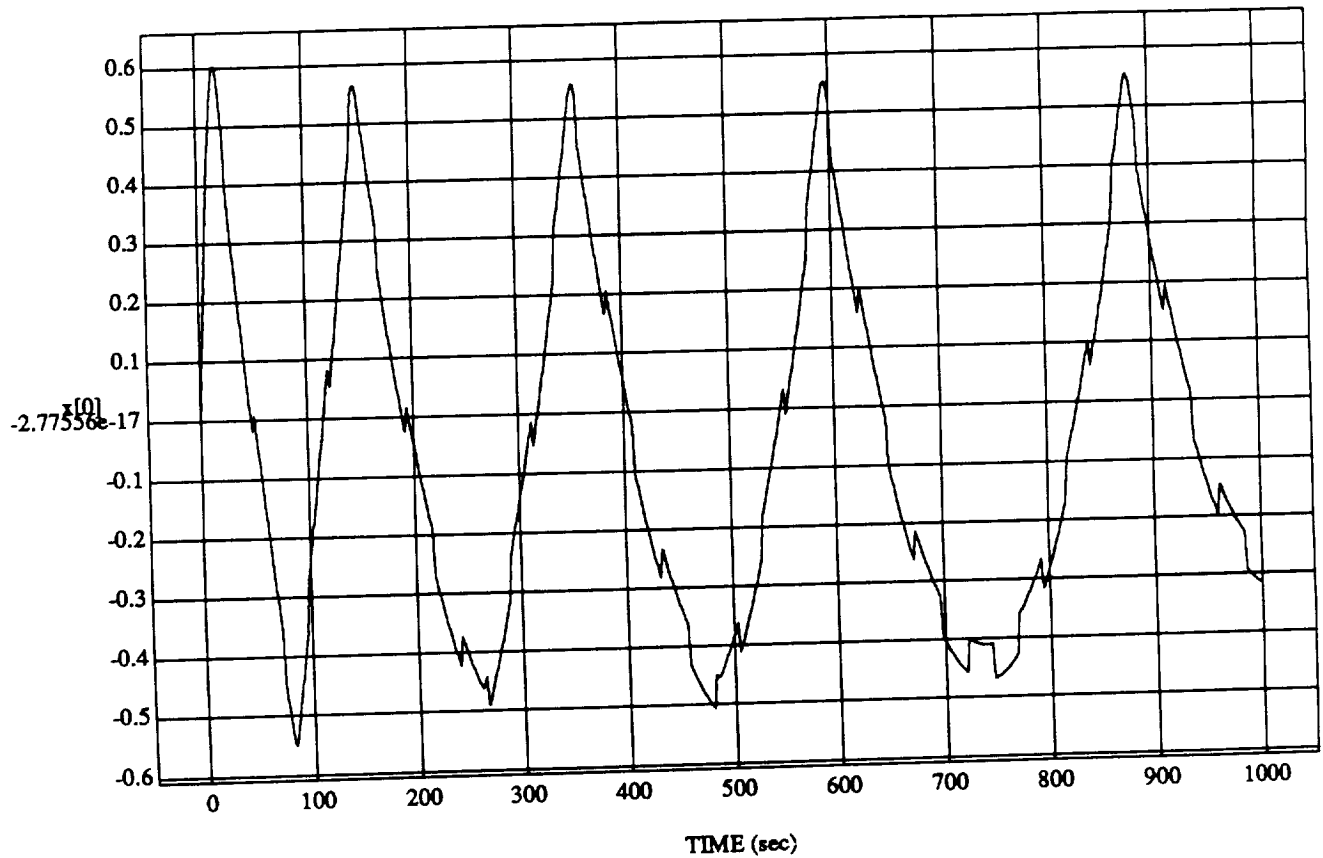
failure vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

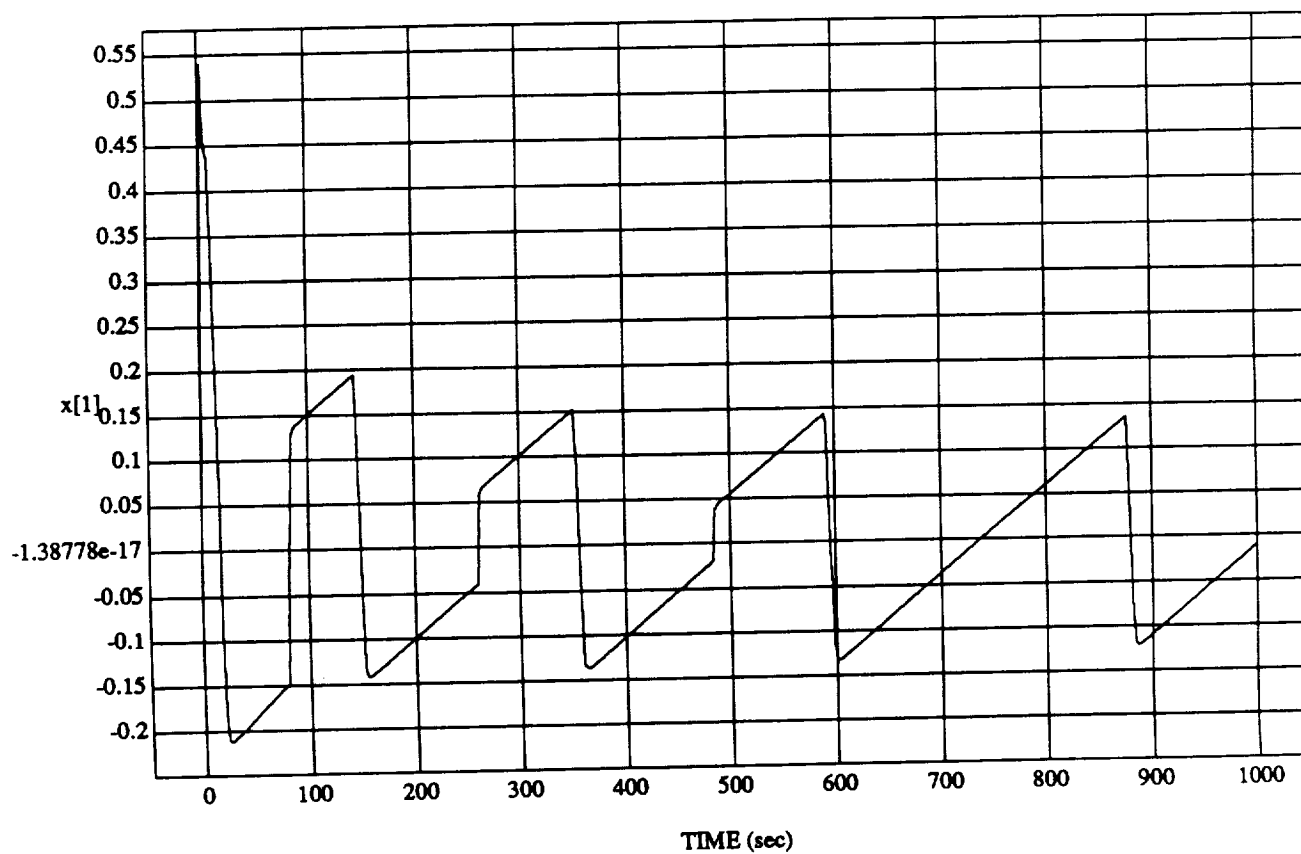
$x[0]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

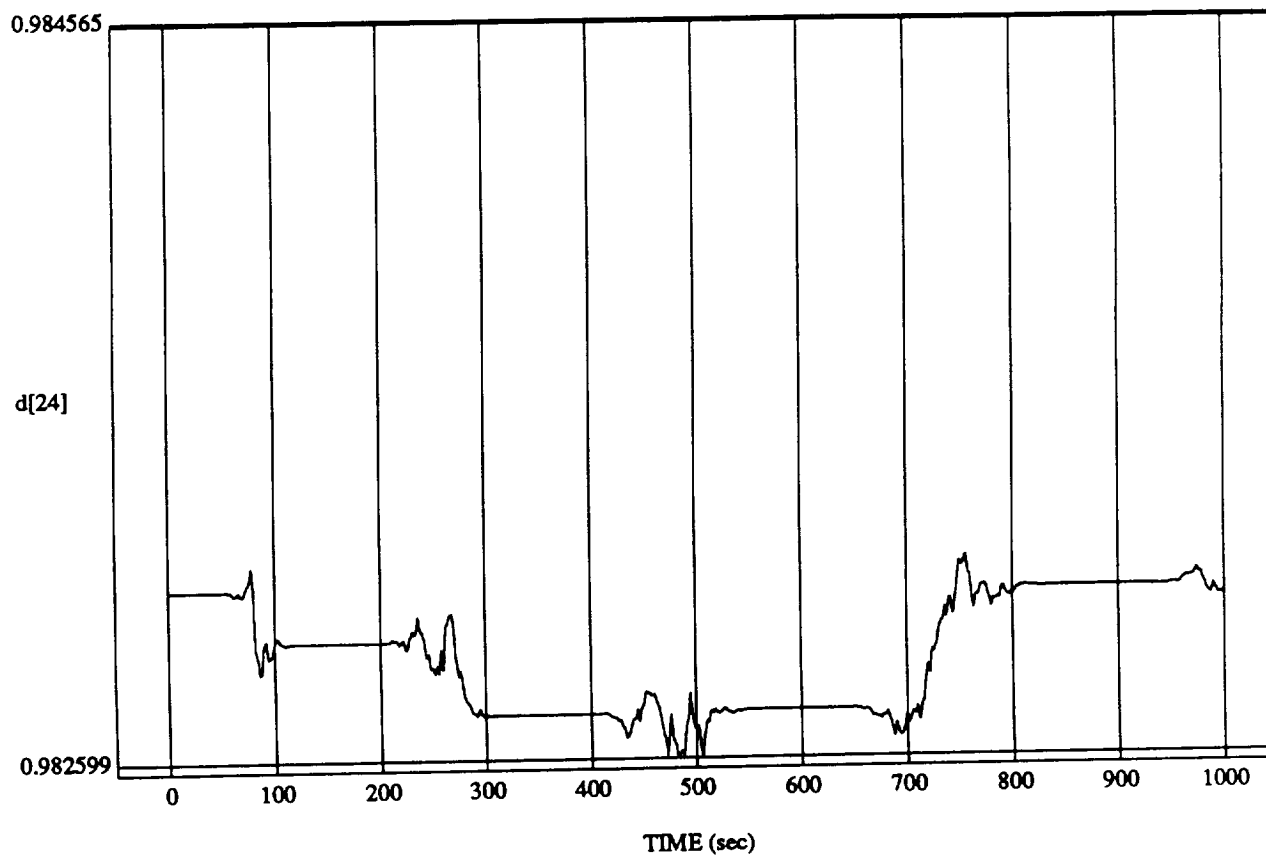
$x[1]$  vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

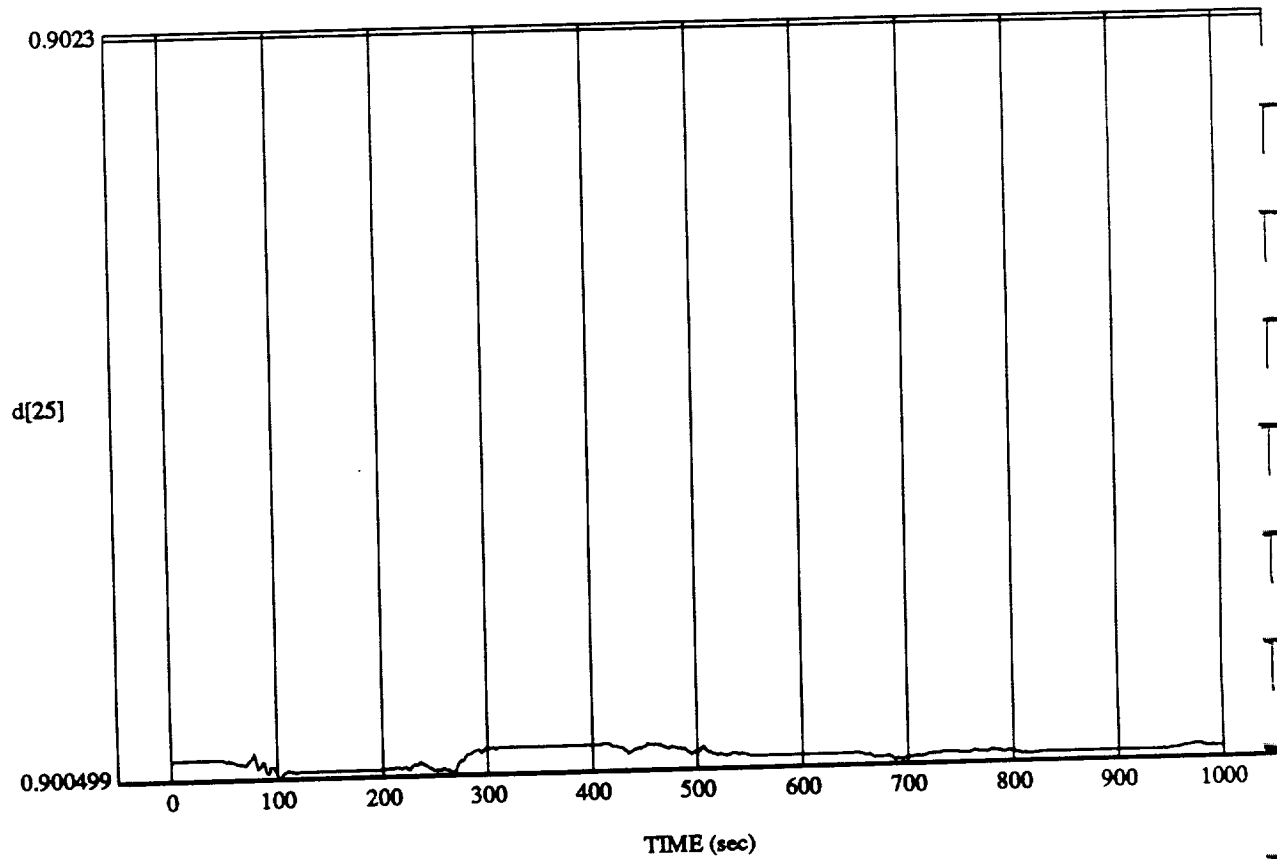
d[24] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

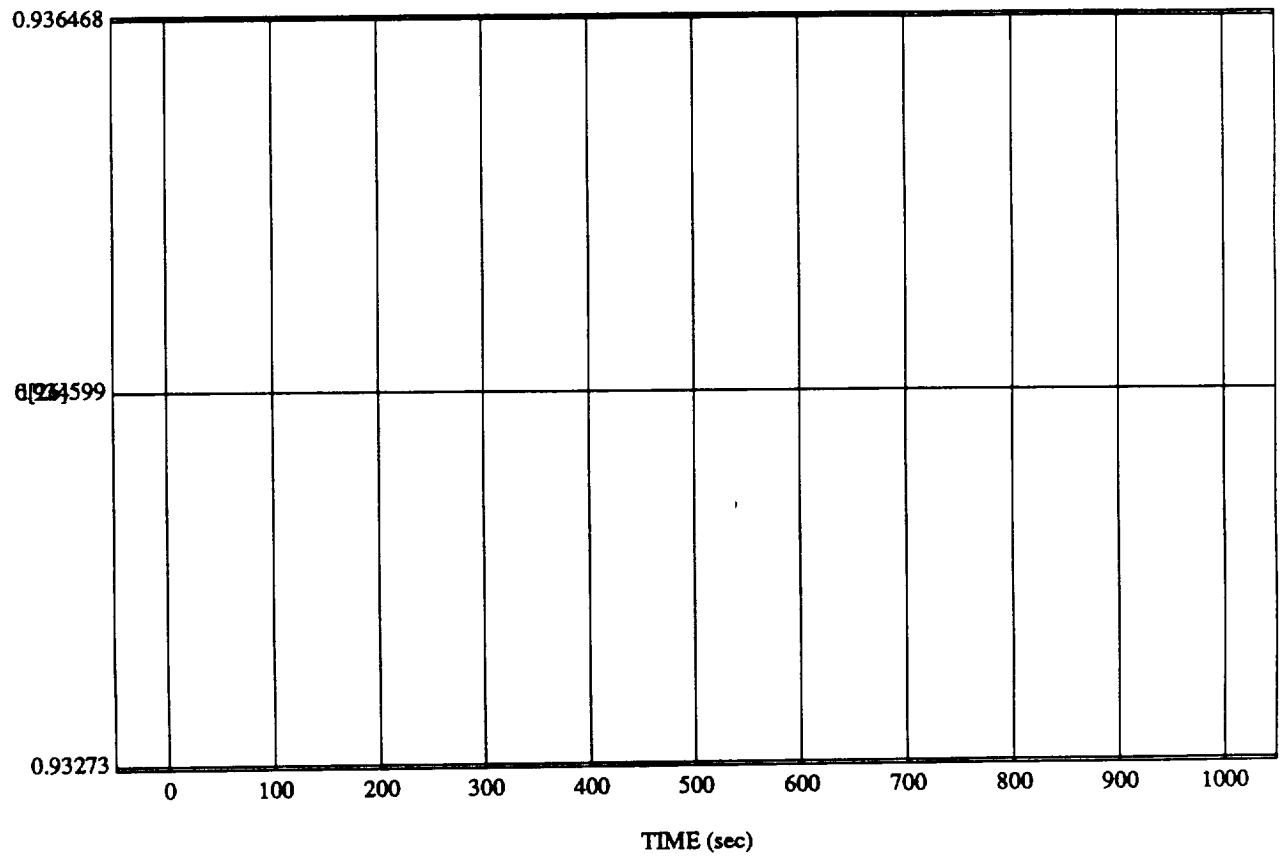
d[25] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

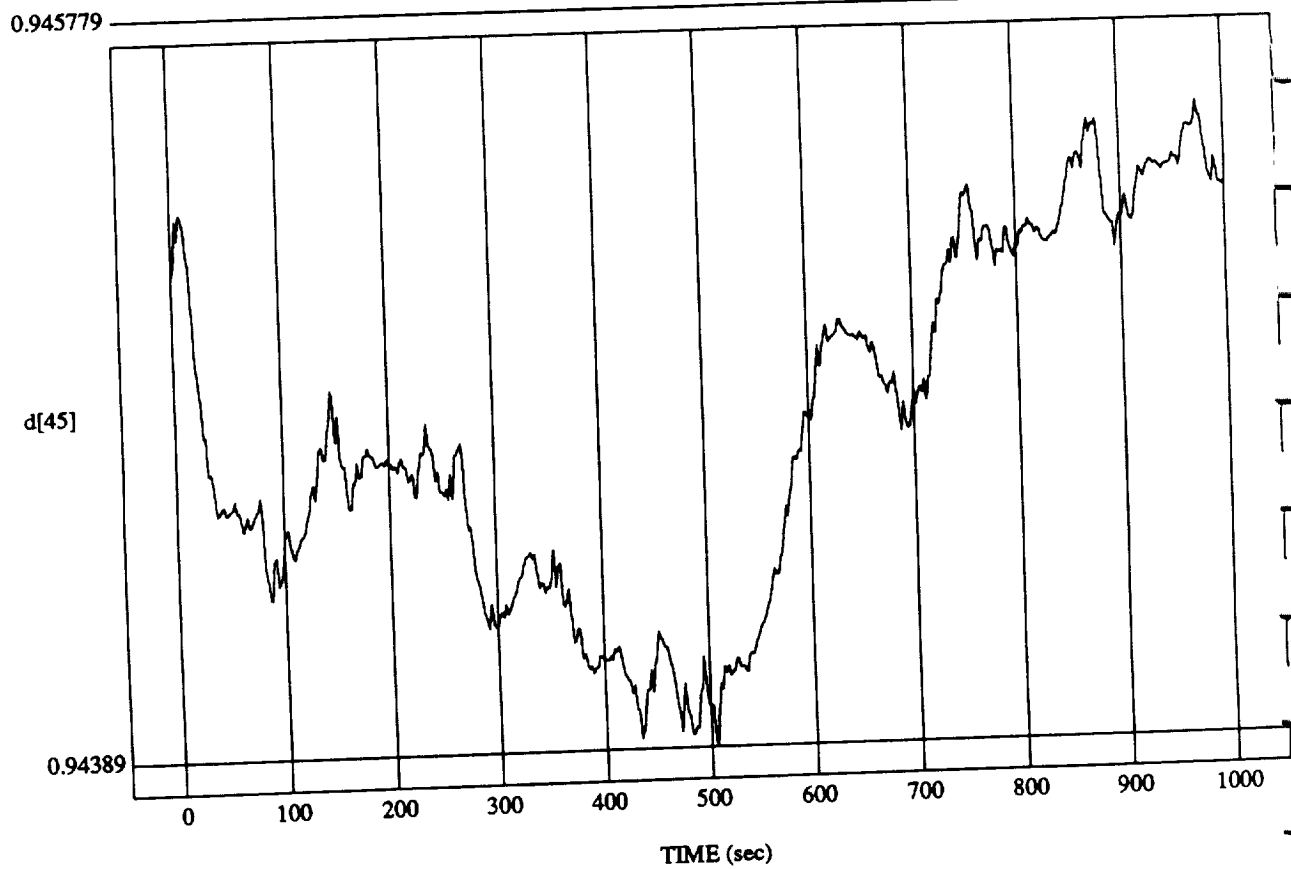
d[26] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[45] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992

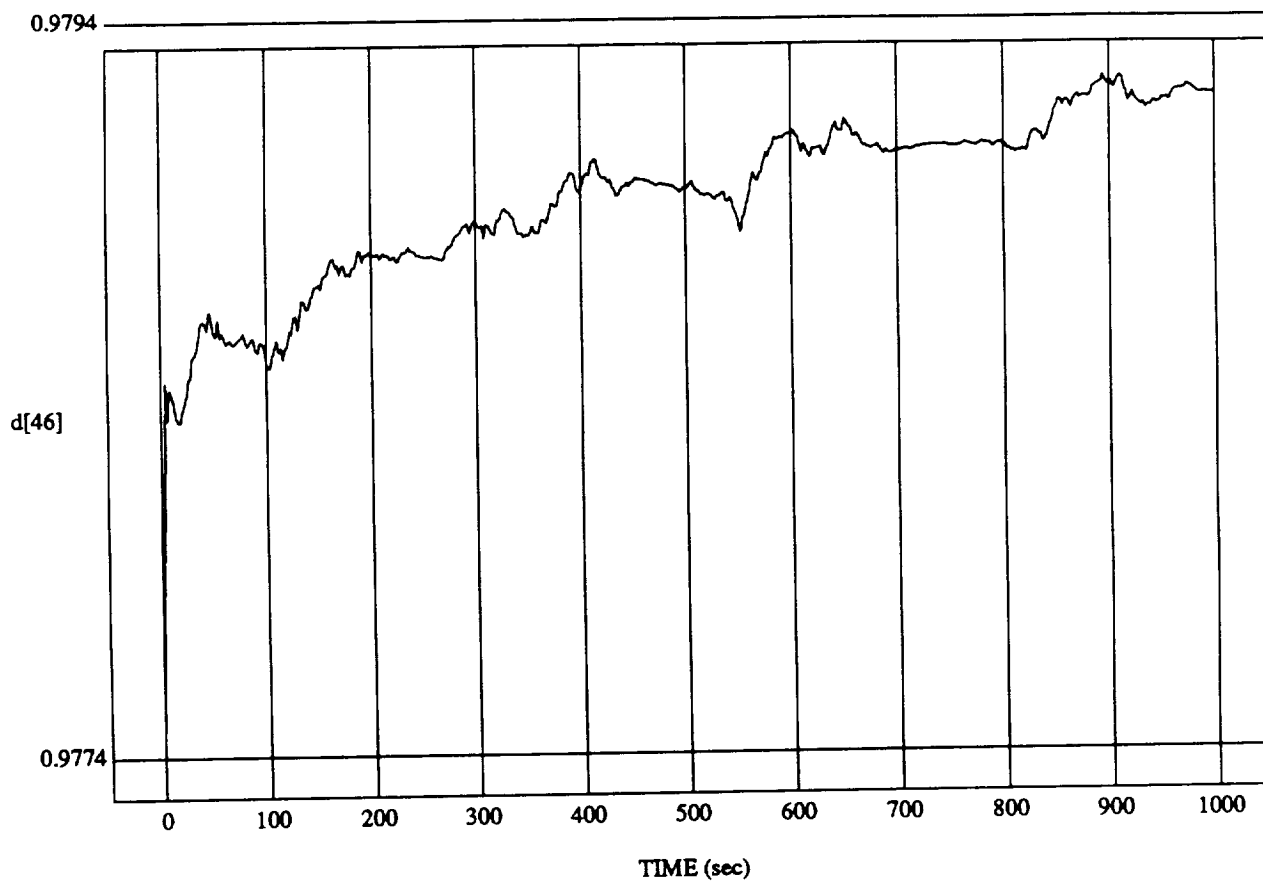


MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.500 Hz



SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

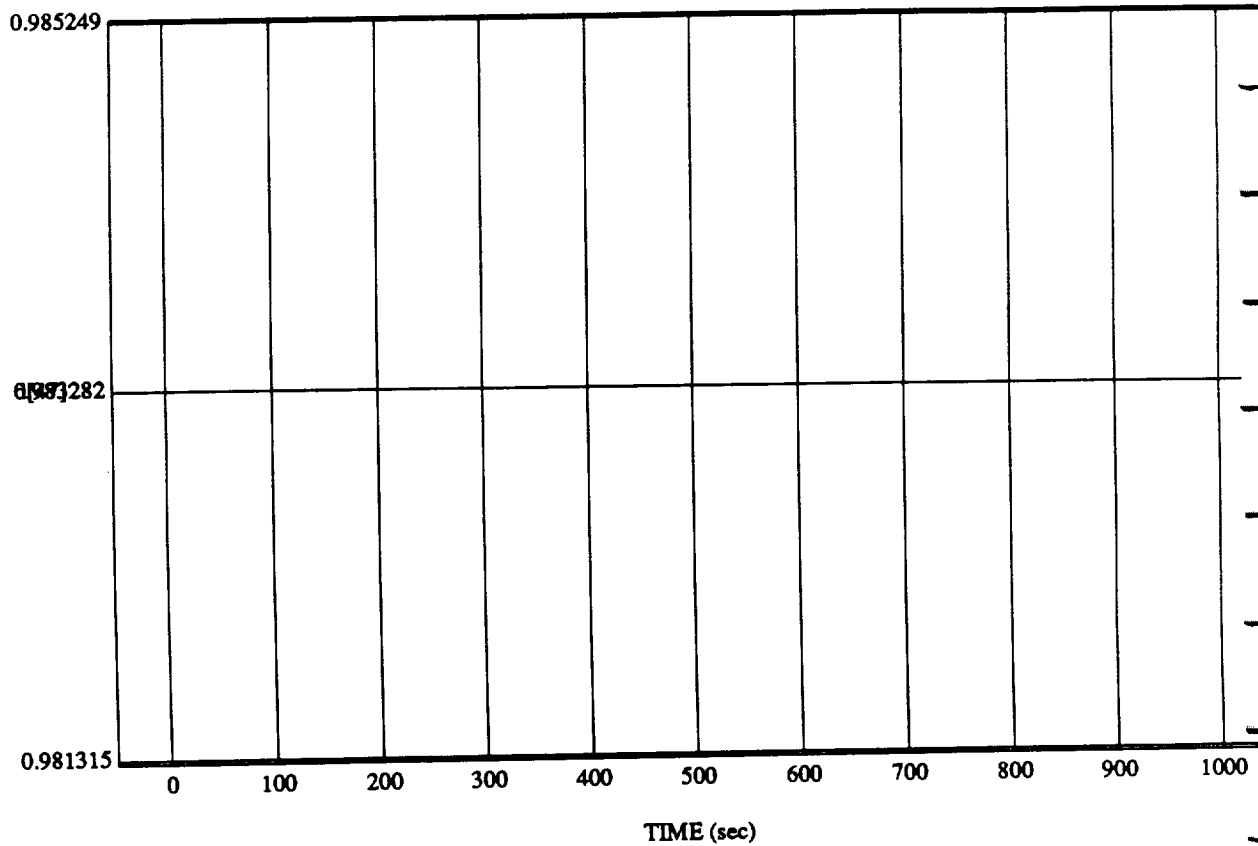
d[46] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

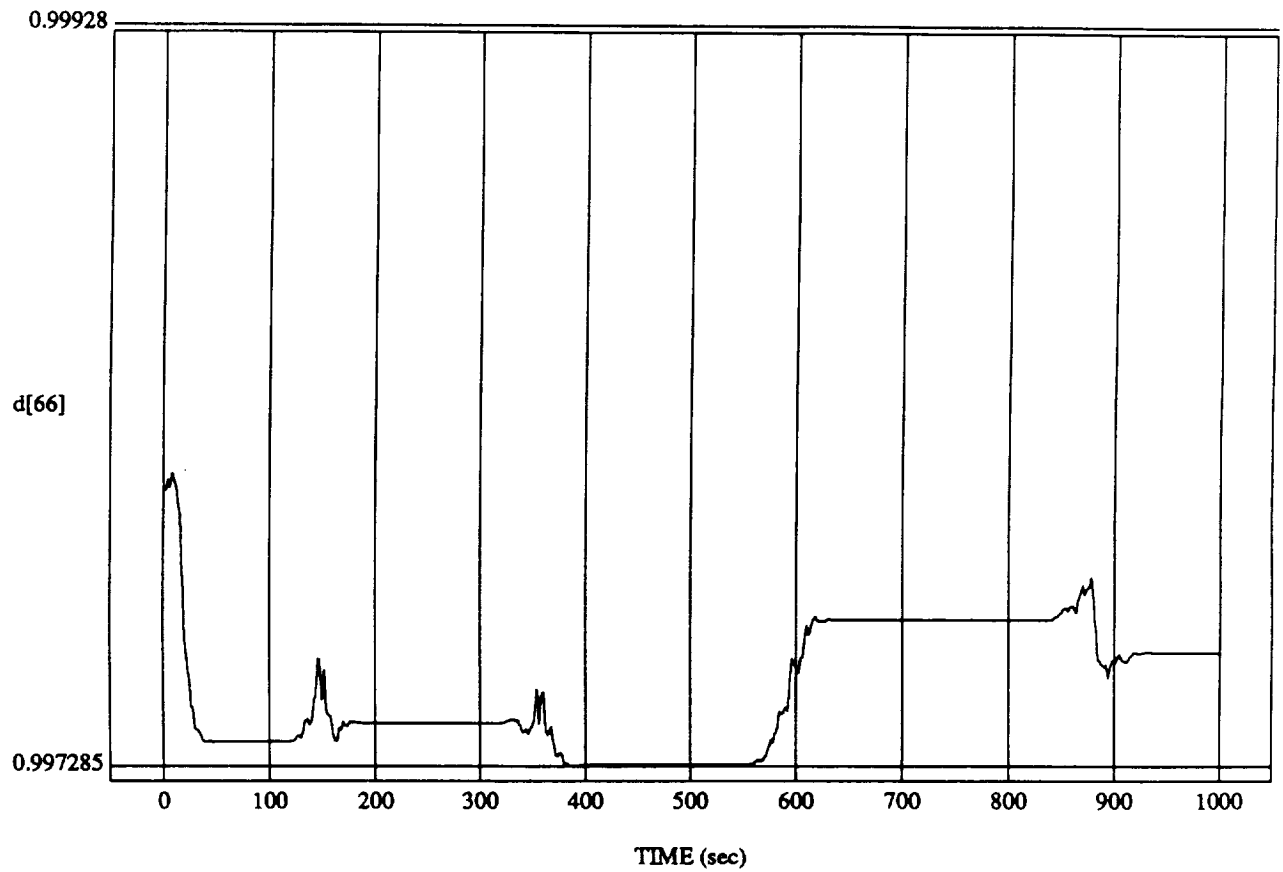
d[47] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

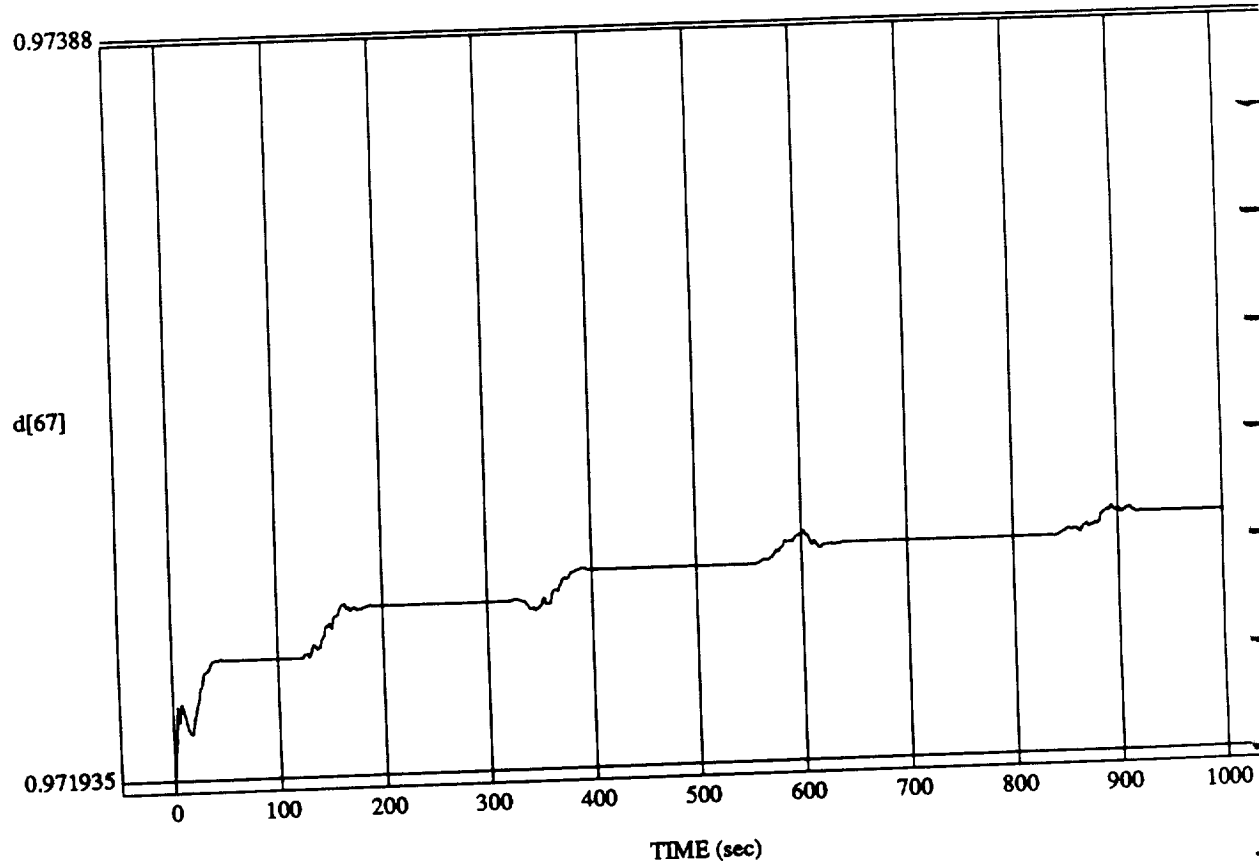
d[66] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

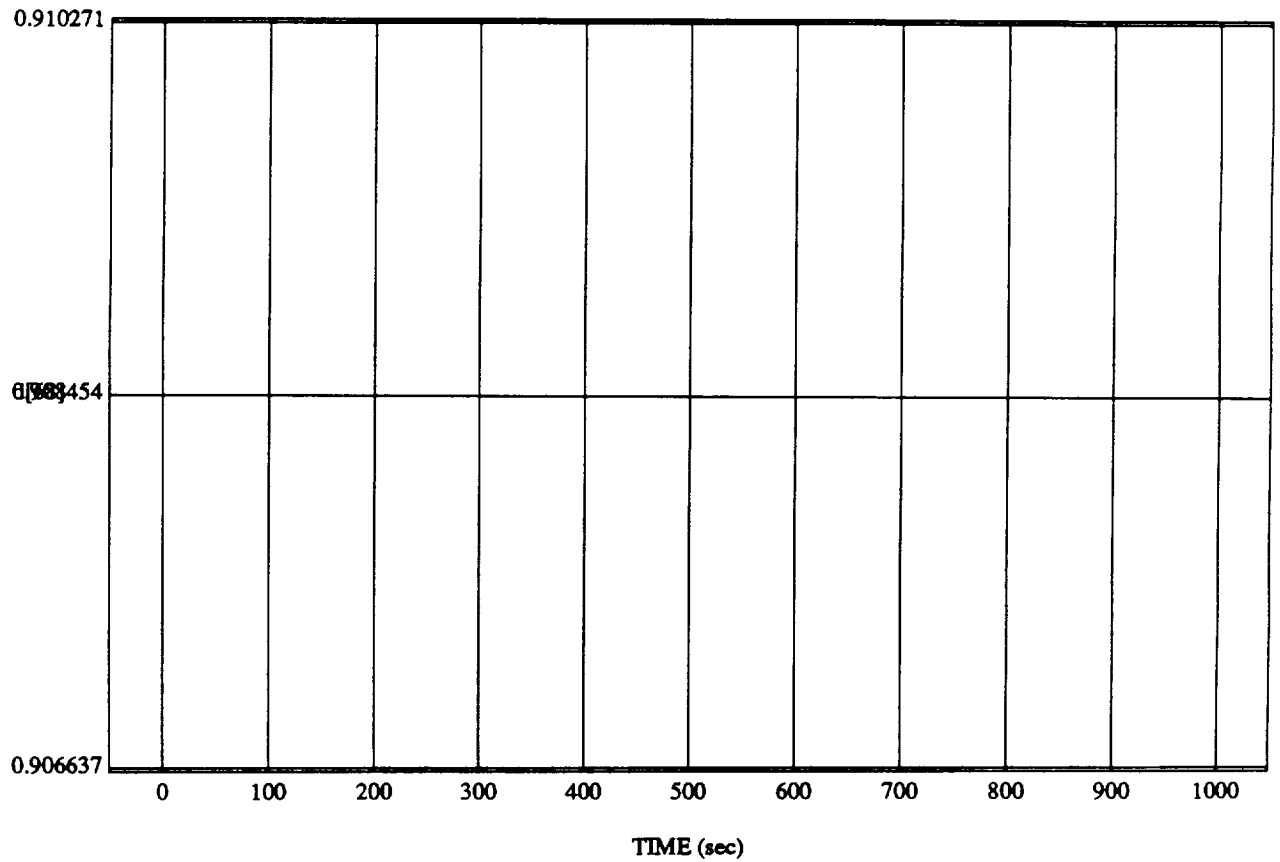
d[67] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz

SIMULATION APPLICATION: FUZZY ORBITER BATCH APPLICATION (9/14/90)

d[68] vs TIME  
RUN: Weights Updated By Rule Strength - 2 July 1992



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.500 Hz





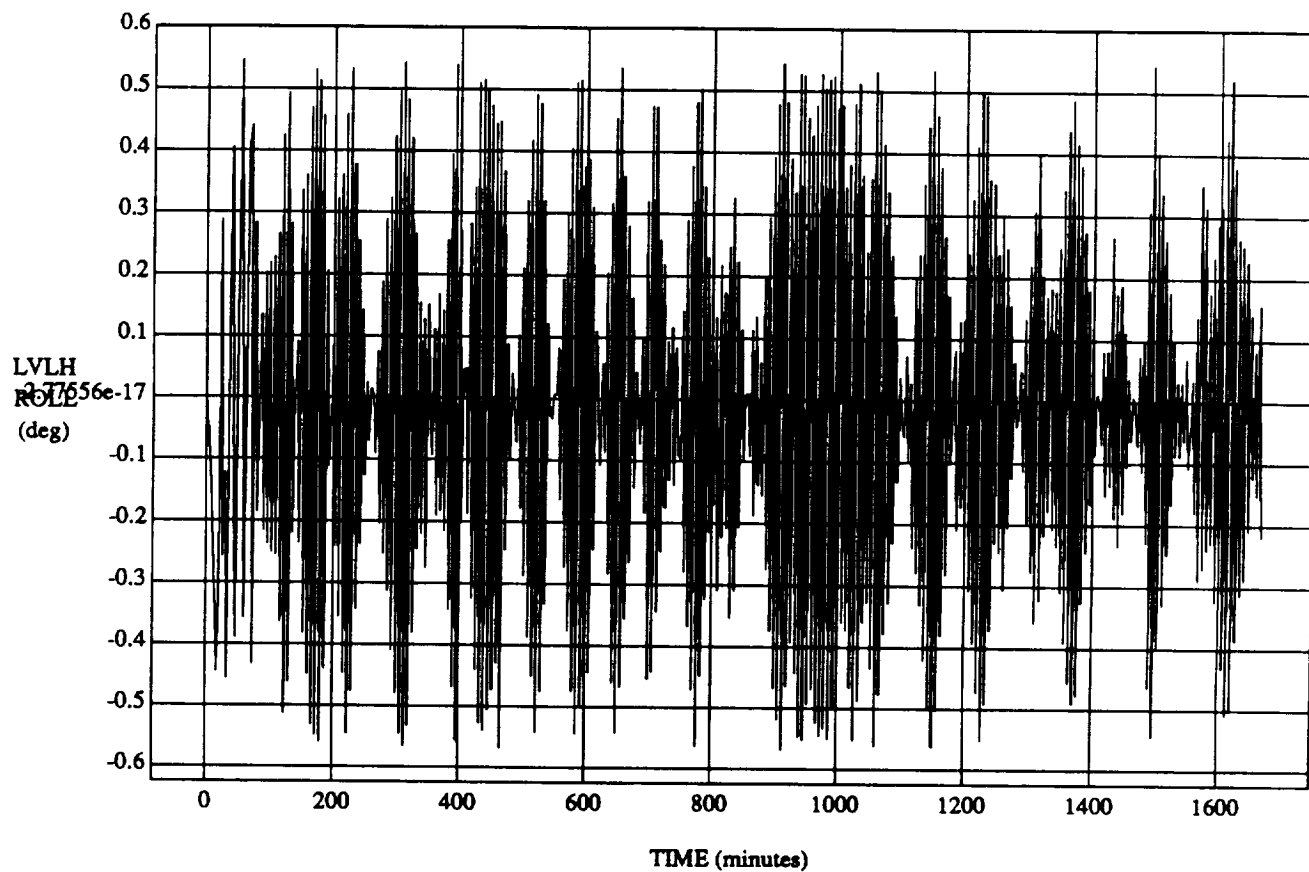




XV  
100,000

# LVLH EULER PYR ROLL vs TIME

RUN: 45 Degree Pitch Attitude Hold

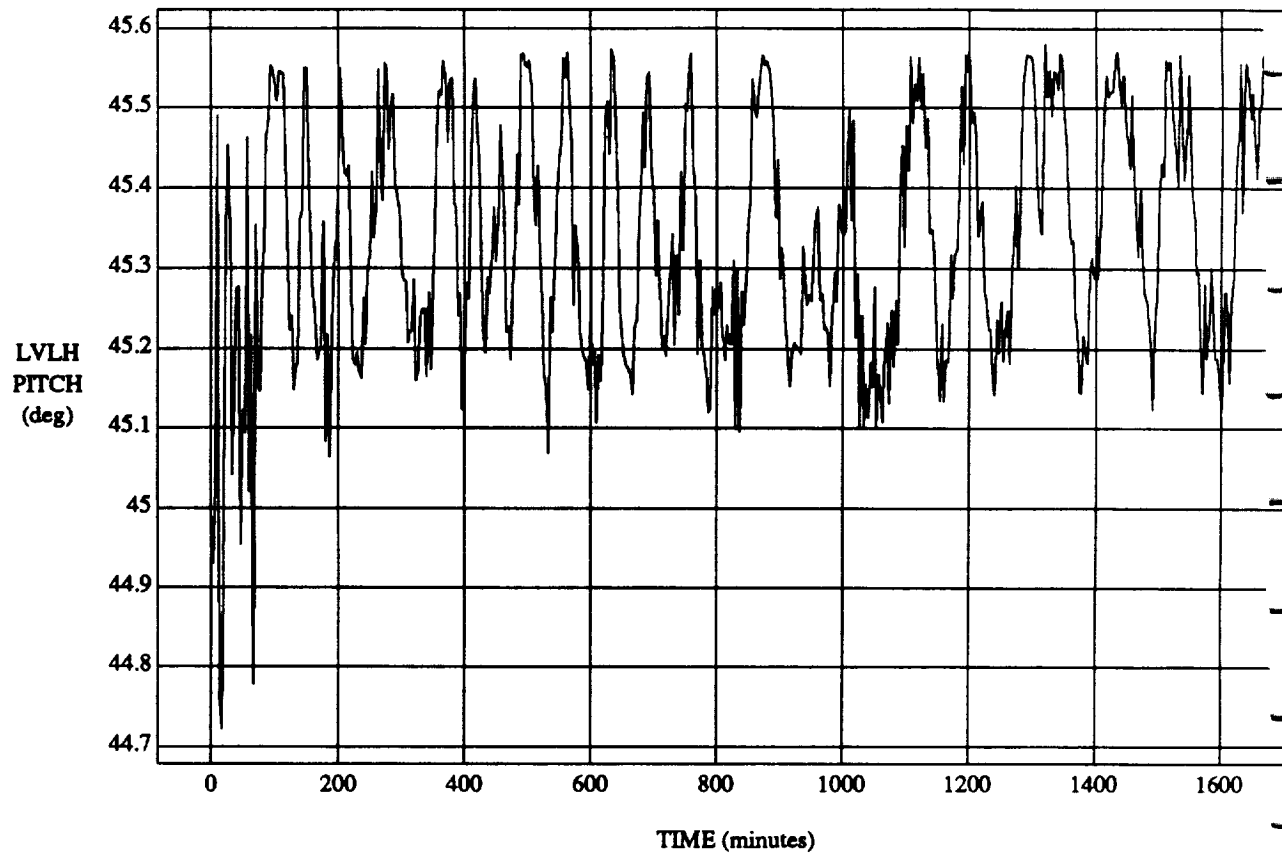


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

### LVLH EULER PYR PITCH vs TIME

RUN: 45 Degree Pitch Attitude Hold

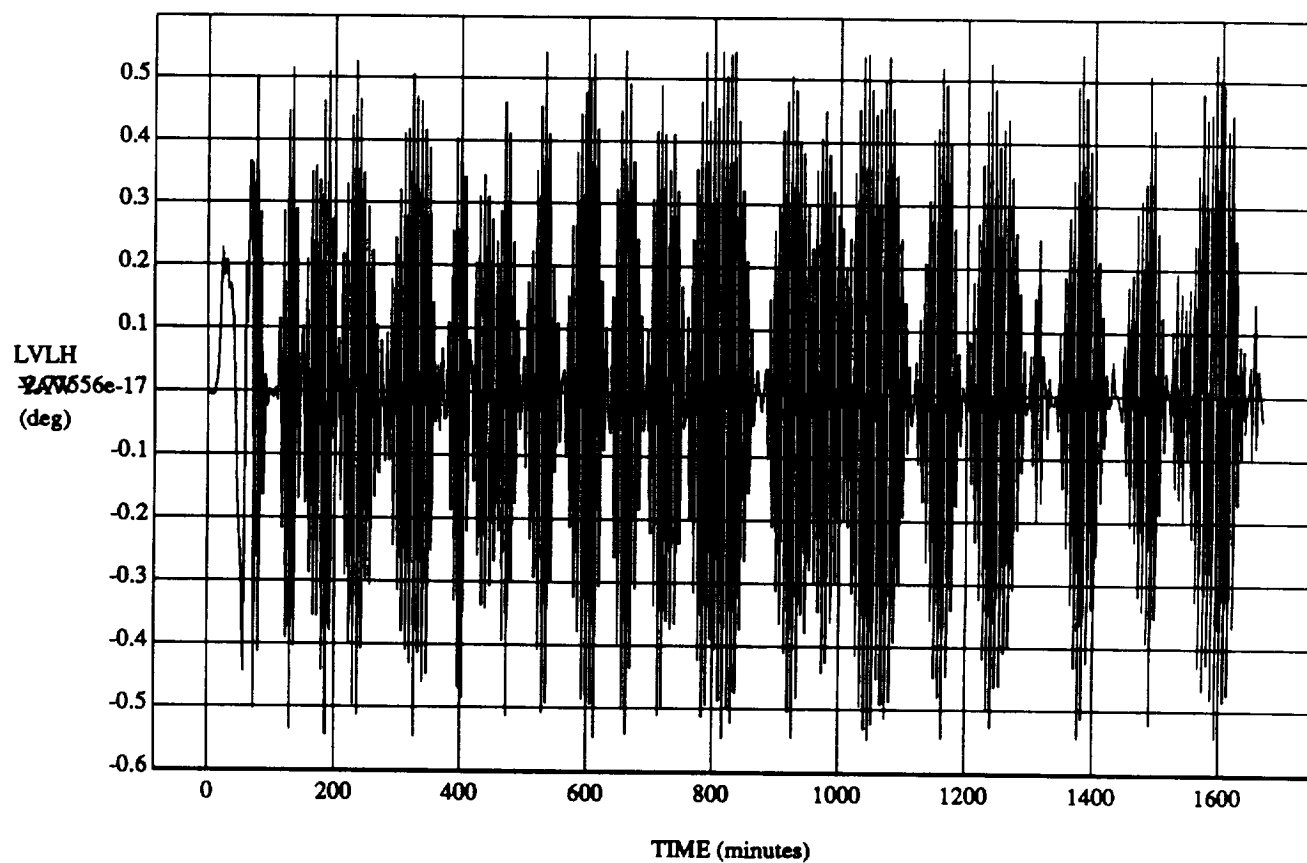


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

# LVLH EULER PYR YAW vs TIME

RUN: 45 Degree Pitch Attitude Hold

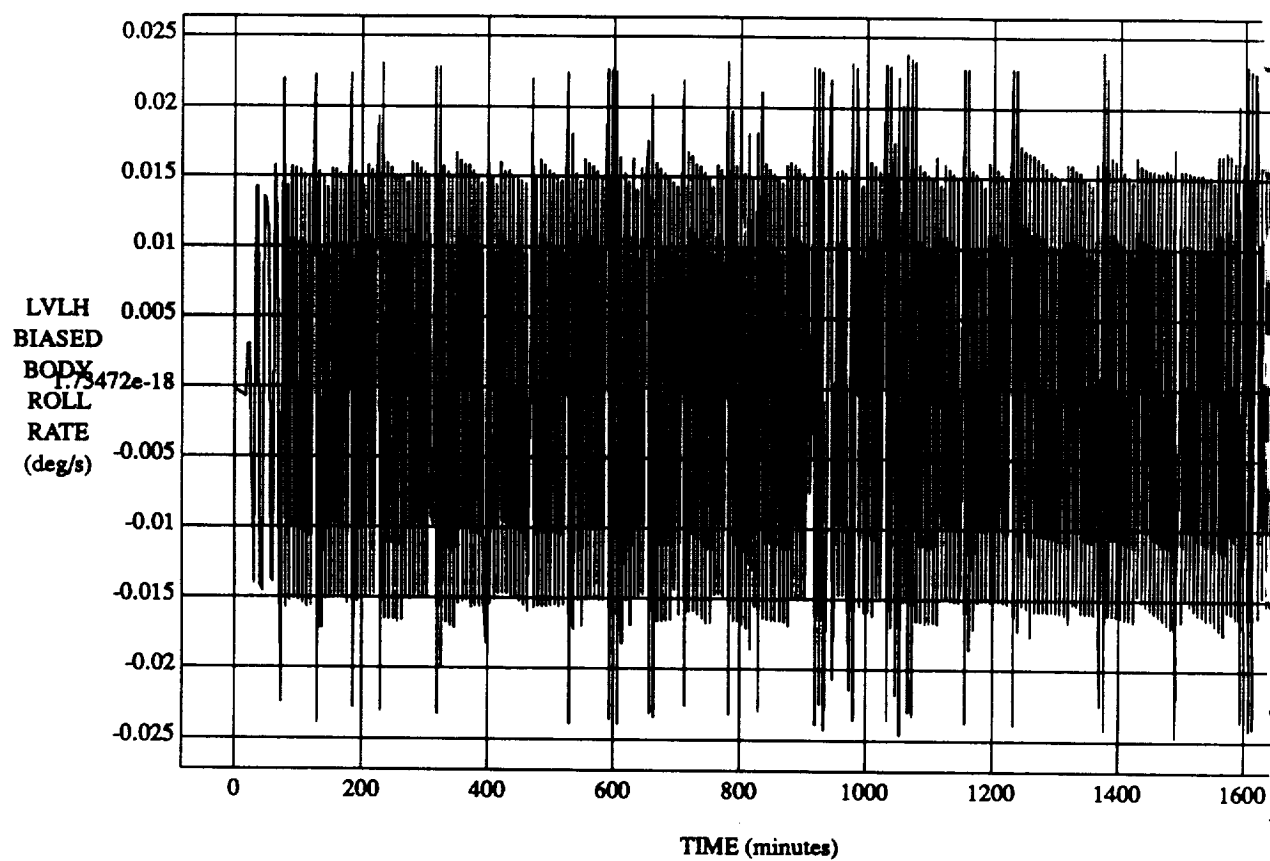


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

### LVLH BIASED BODY ROLL RATE vs TIME

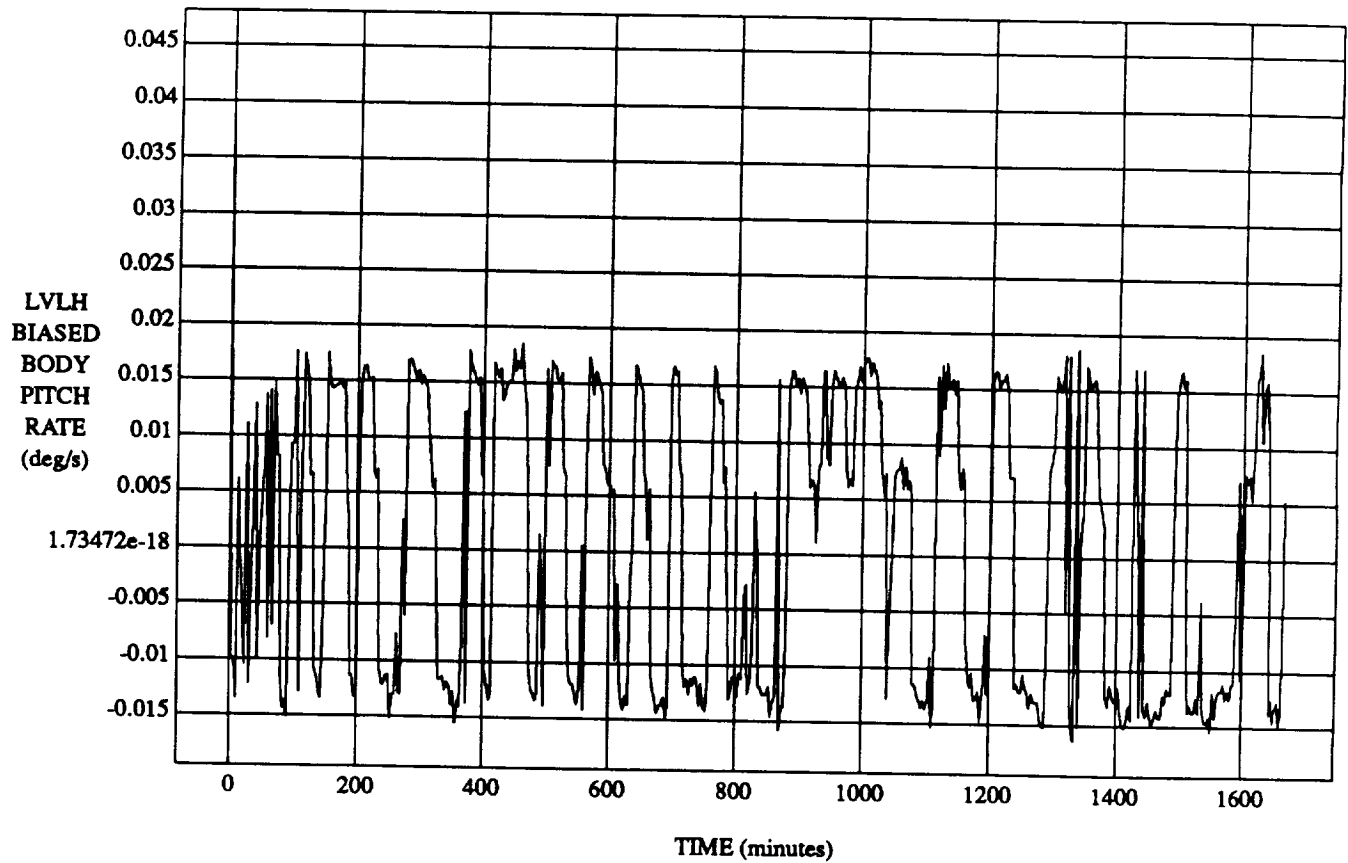
RUN: 45 Degree Pitch Attitude Hold



VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

# LVLH BIASED BODY PITCH RATE vs TIME

RUN: 45 Degree Pitch Attitude Hold

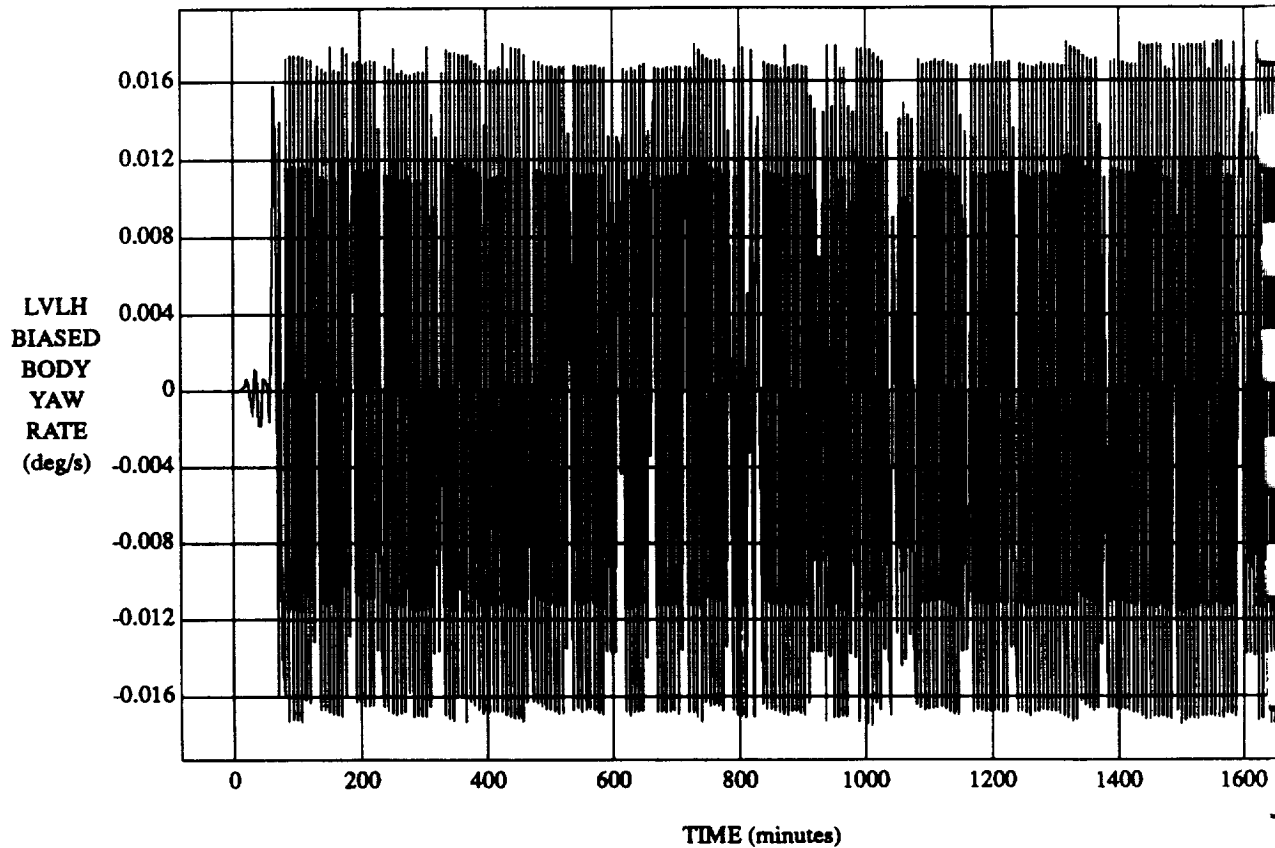


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

## LVLH BIASED BODY YAW RATE vs TIME

RUN: 45 Degree Pitch Attitude Hold

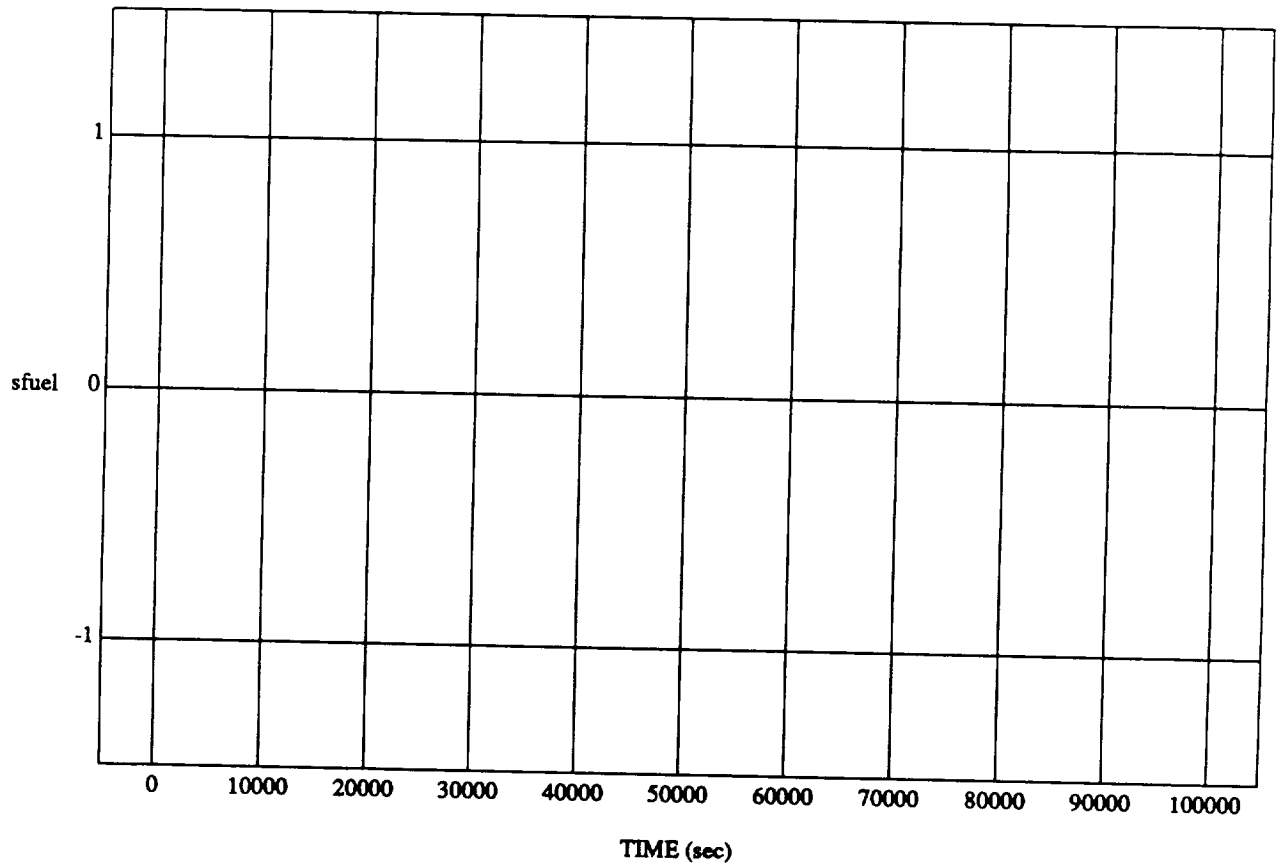


VEHICLE: ORB\_FUZZ\_BATCH.state

DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

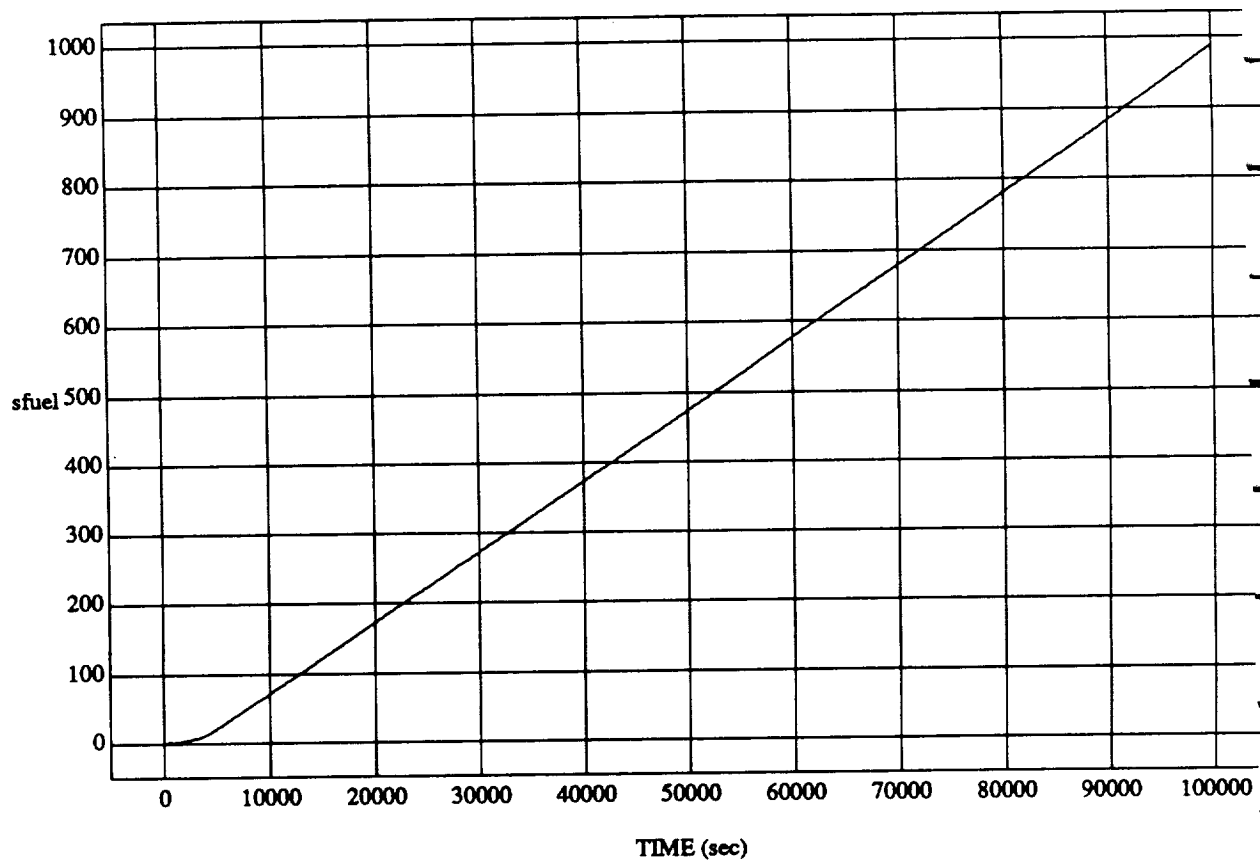
**sfuel vs TIME**  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.primary  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

**sfuel vs TIME**  
RUN: 45 Degree Pitch Attitude Hold

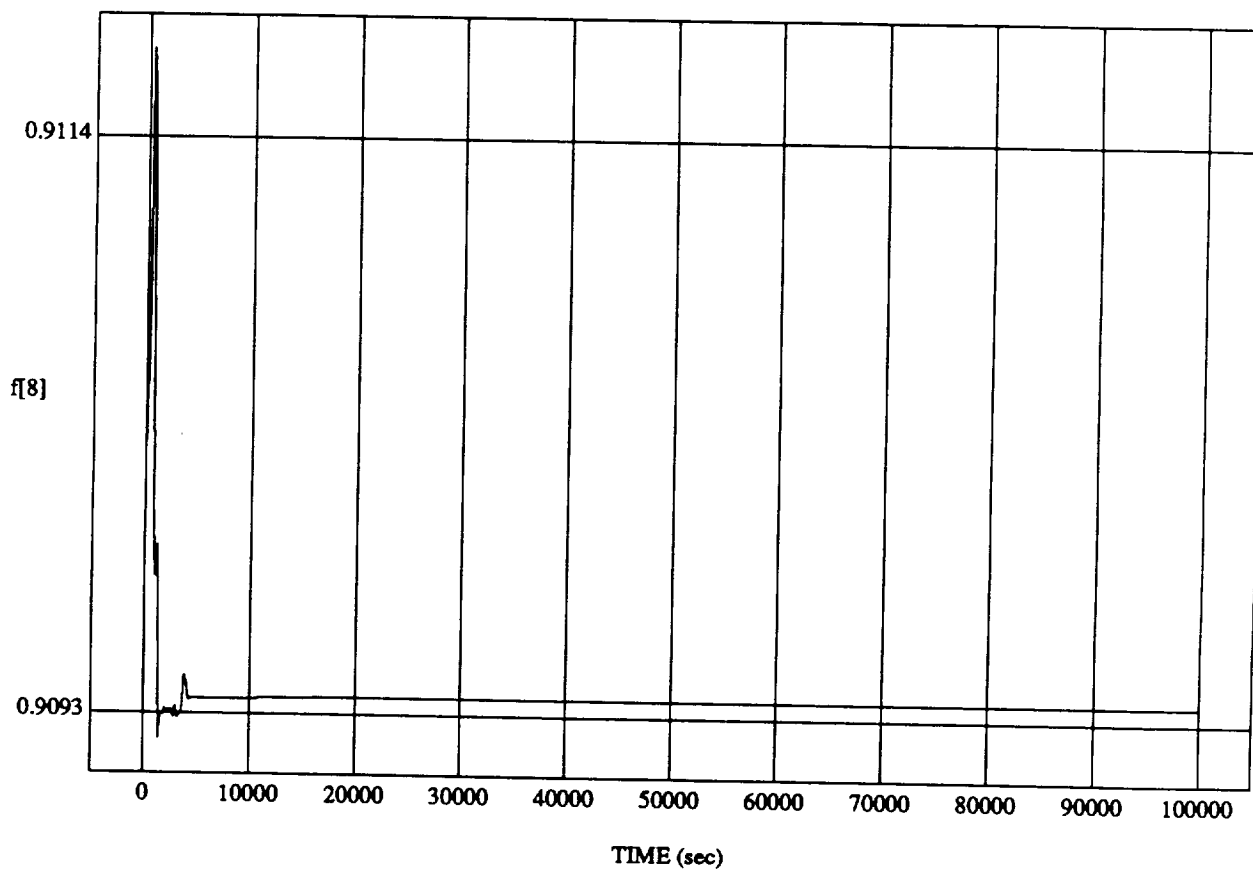


MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

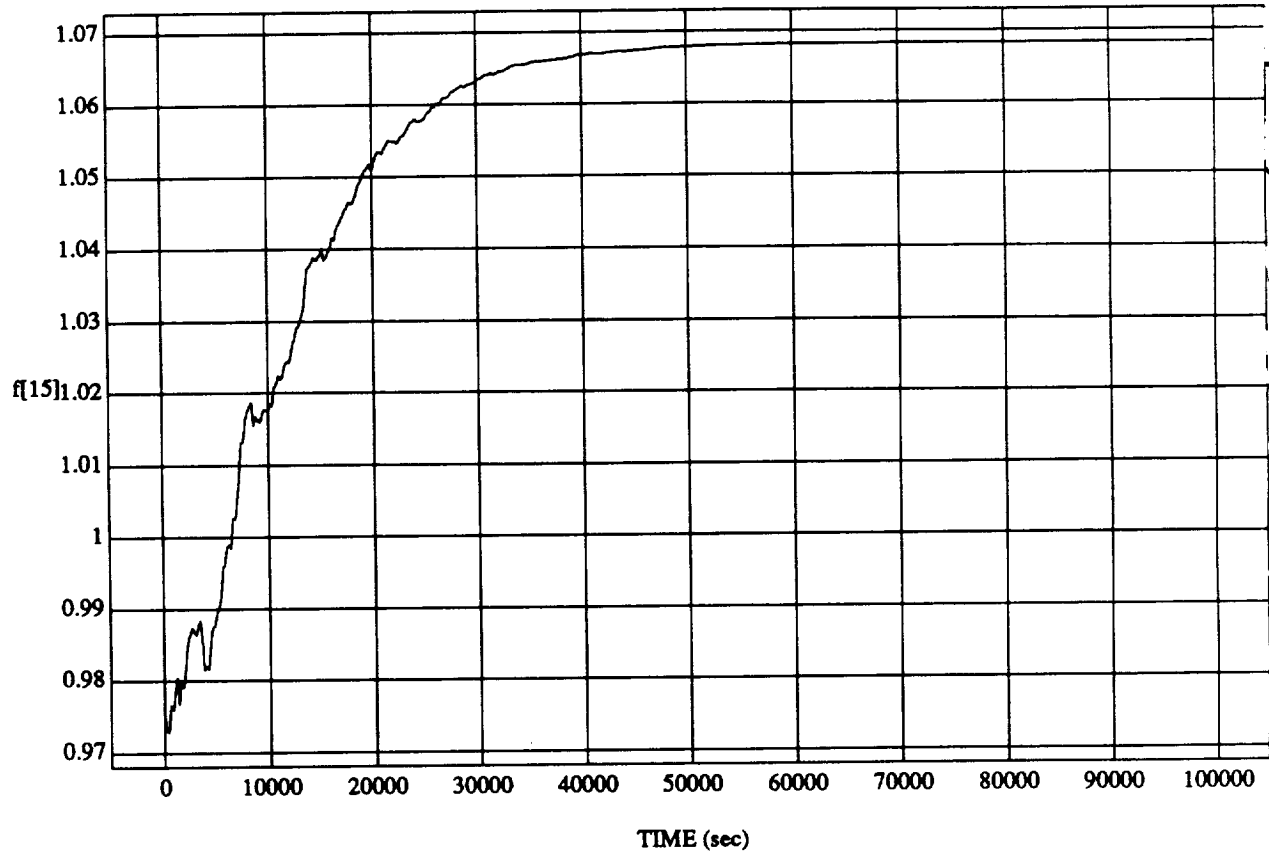
$f[8]$  vs TIME  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

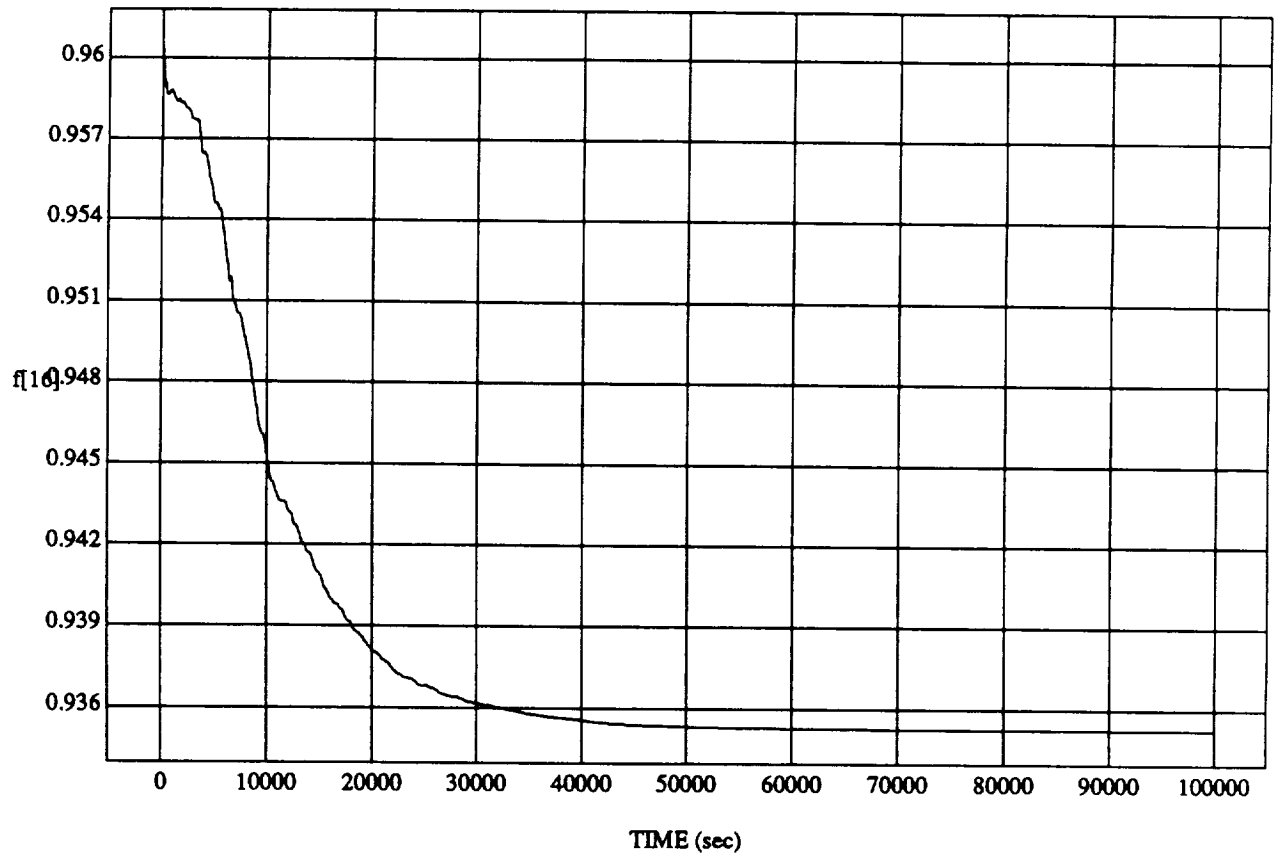
f[15] vs TIME  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

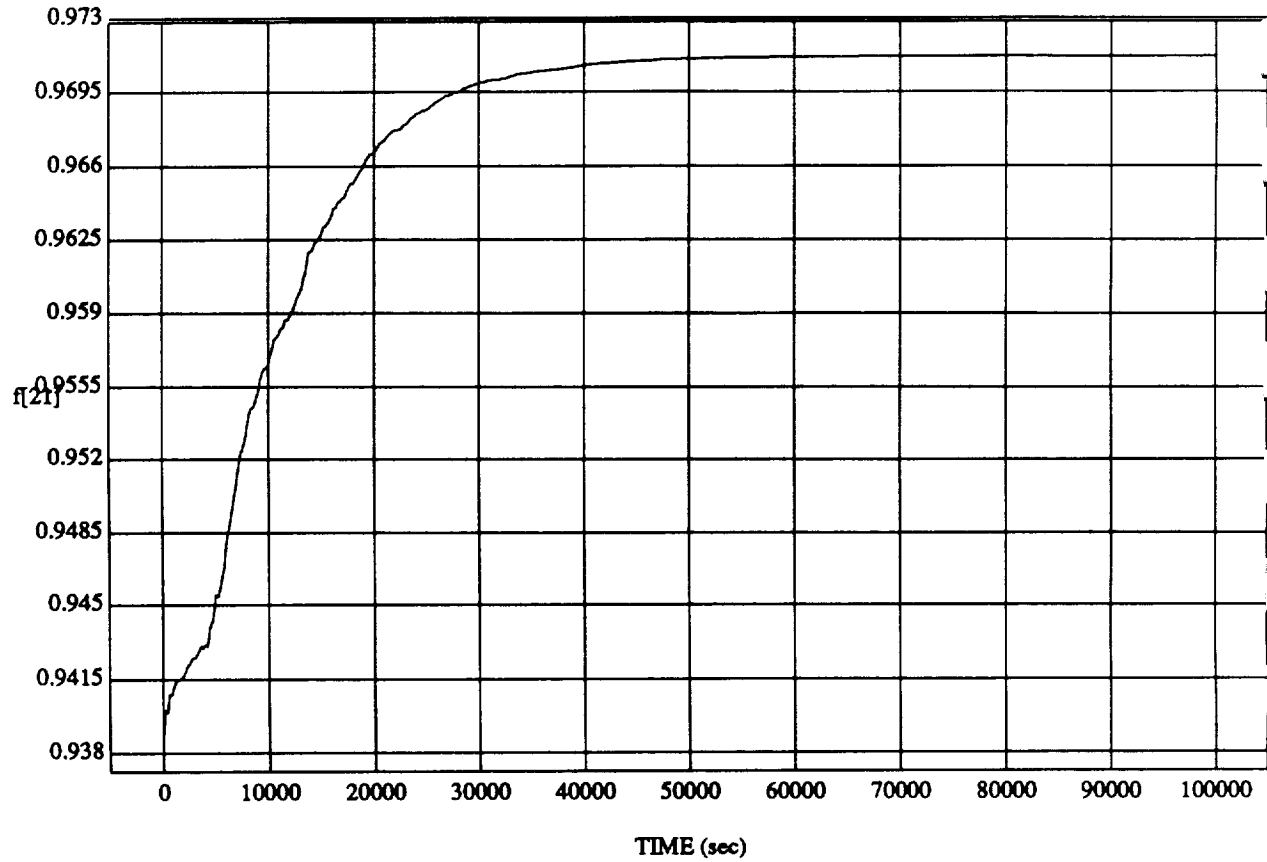
**f[16] vs TIME**  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

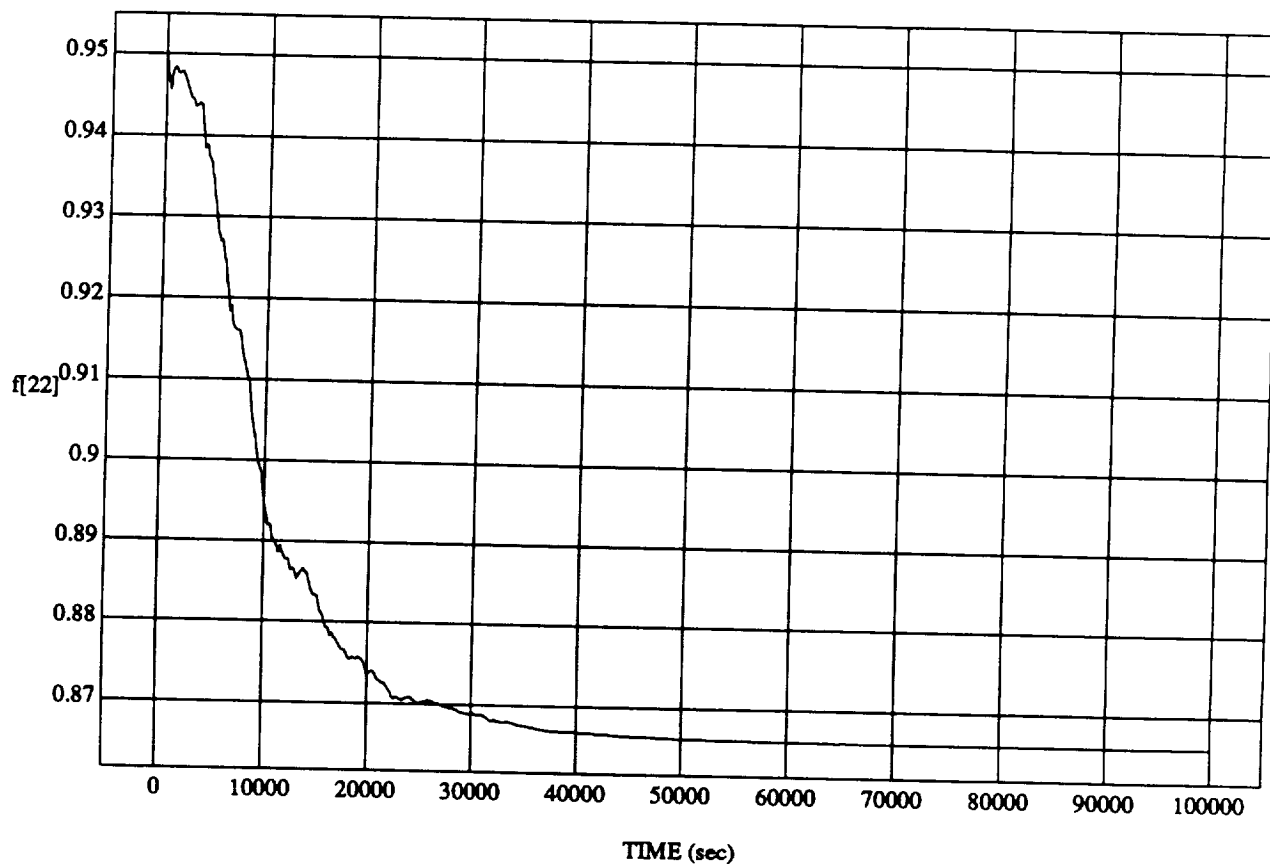
$f[21]$  vs TIME  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

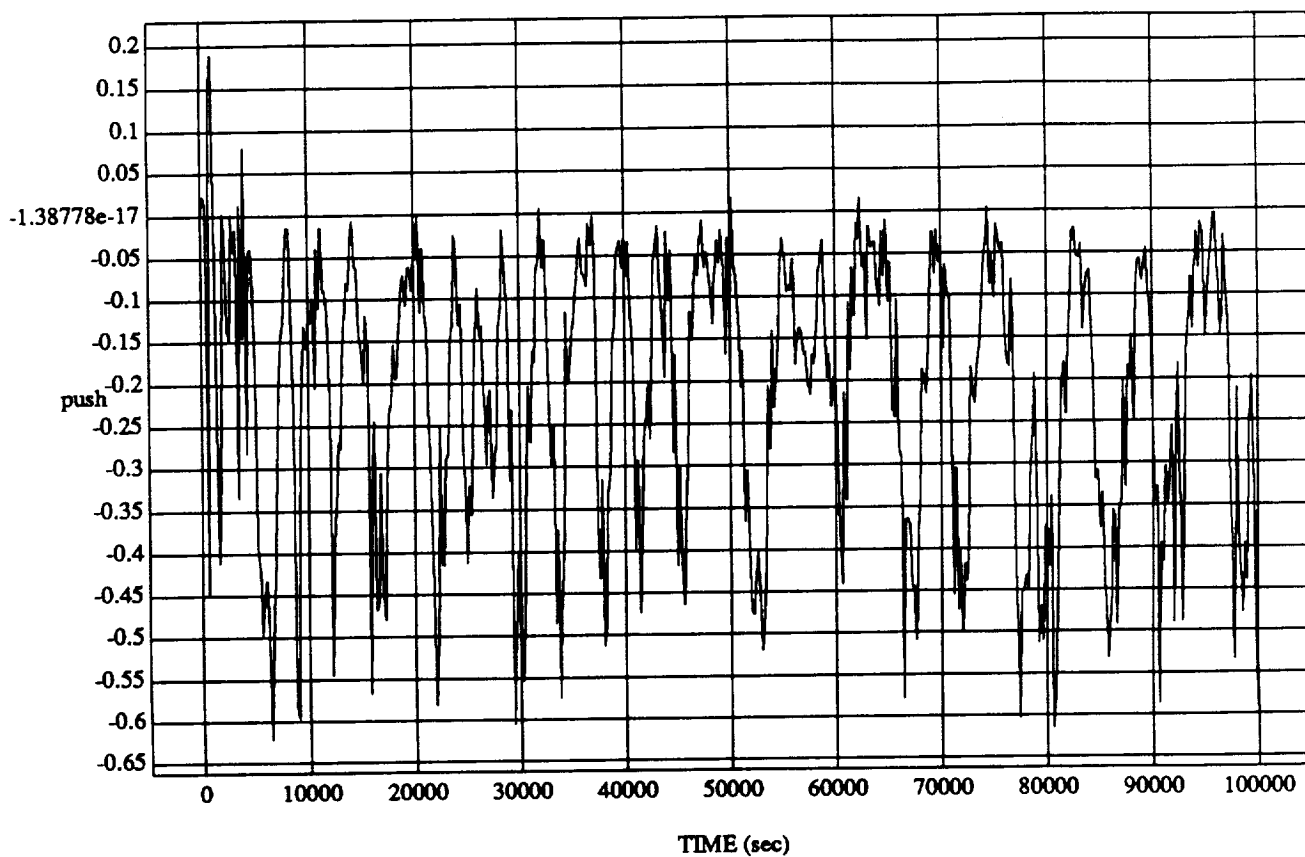
**f[22] vs TIME**  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

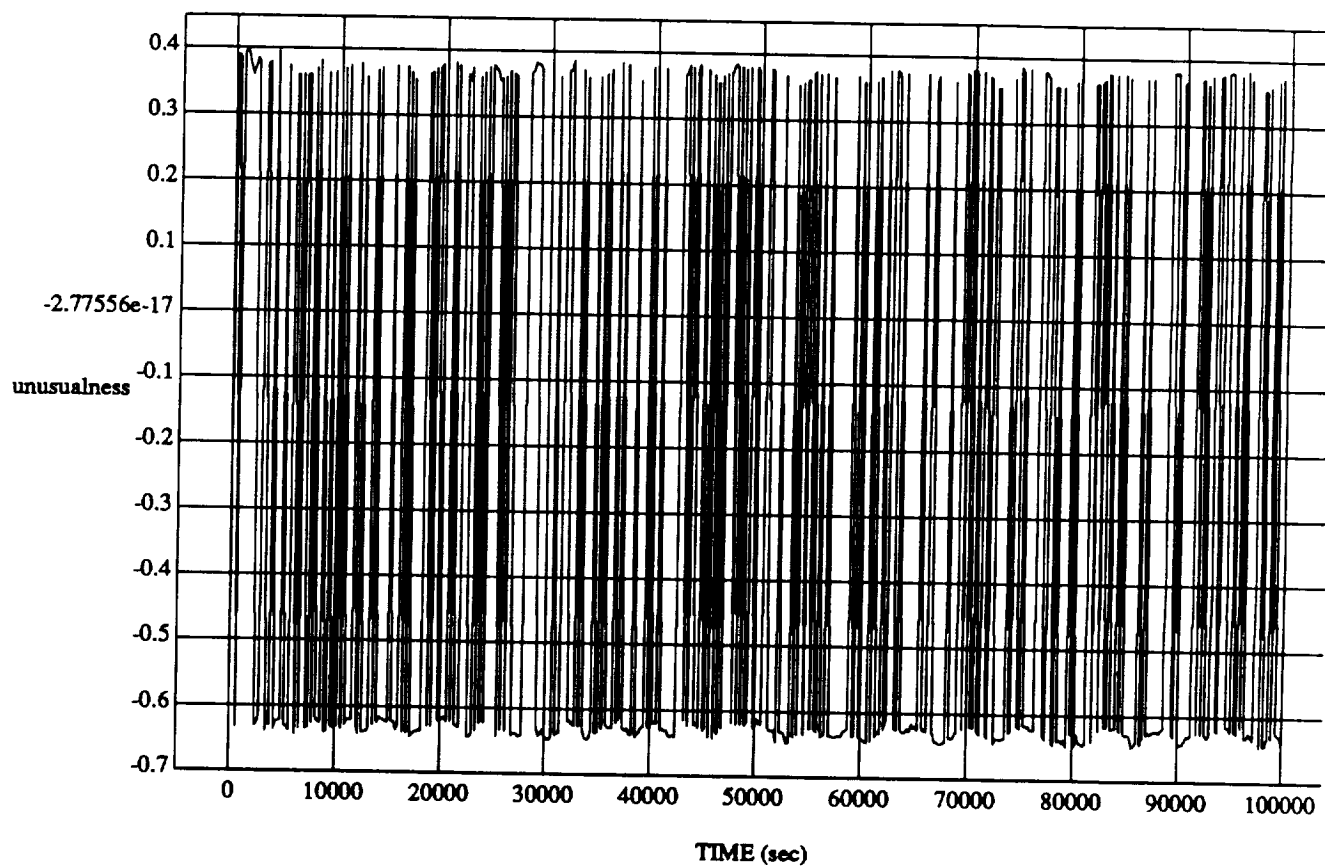
push vs TIME  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

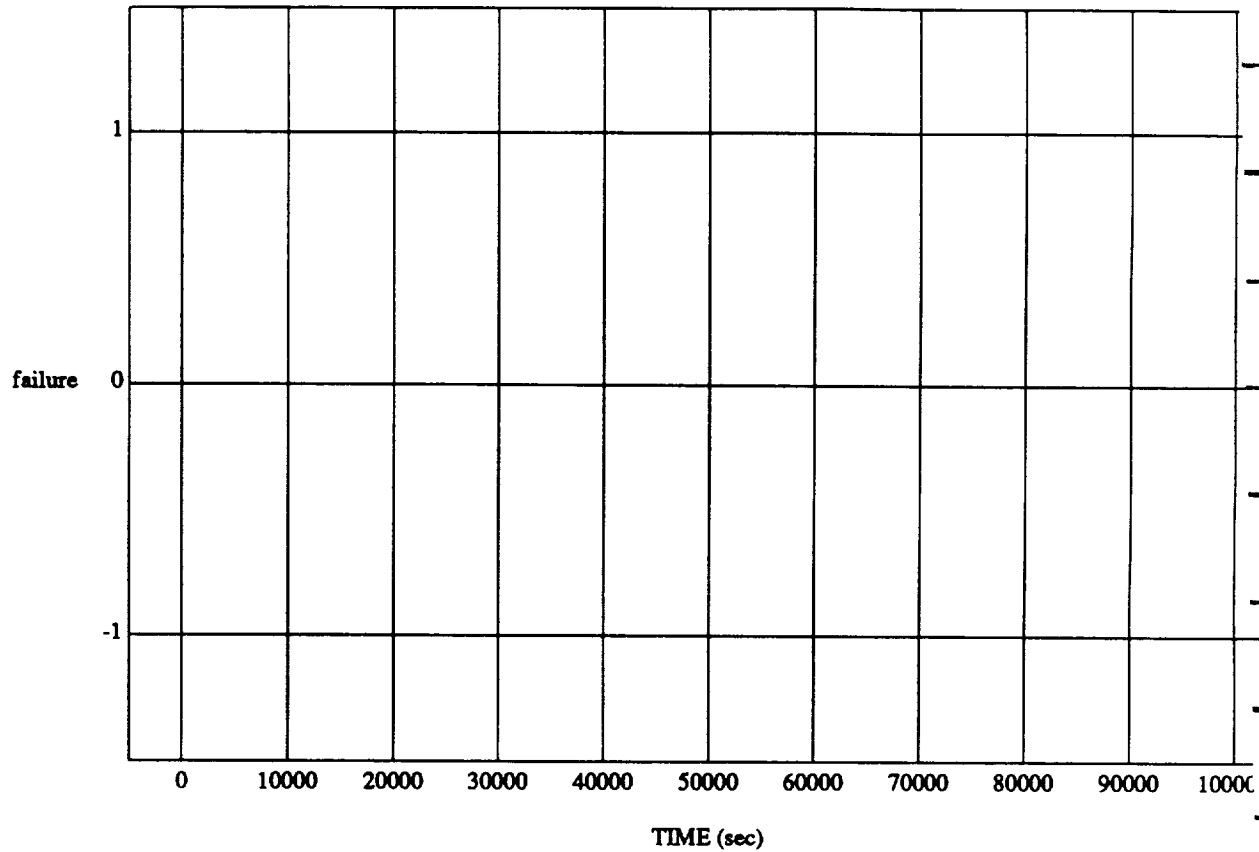
unusualness vs TIME  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

**failure vs TIME**  
RUN: 45 Degree Pitch Attitude Hold

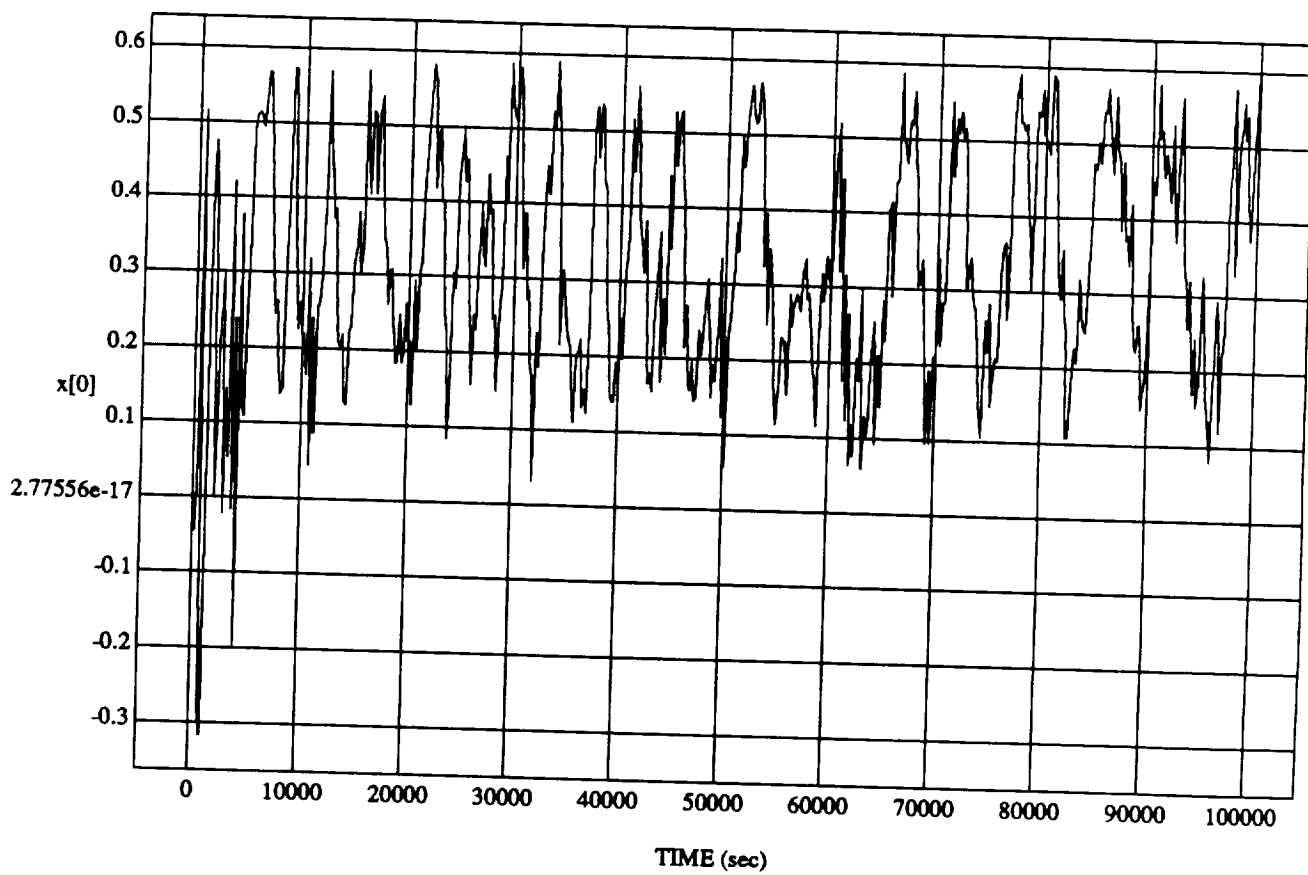


MODULE: ORB\_FUZZ\_BATCHlearn2  
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

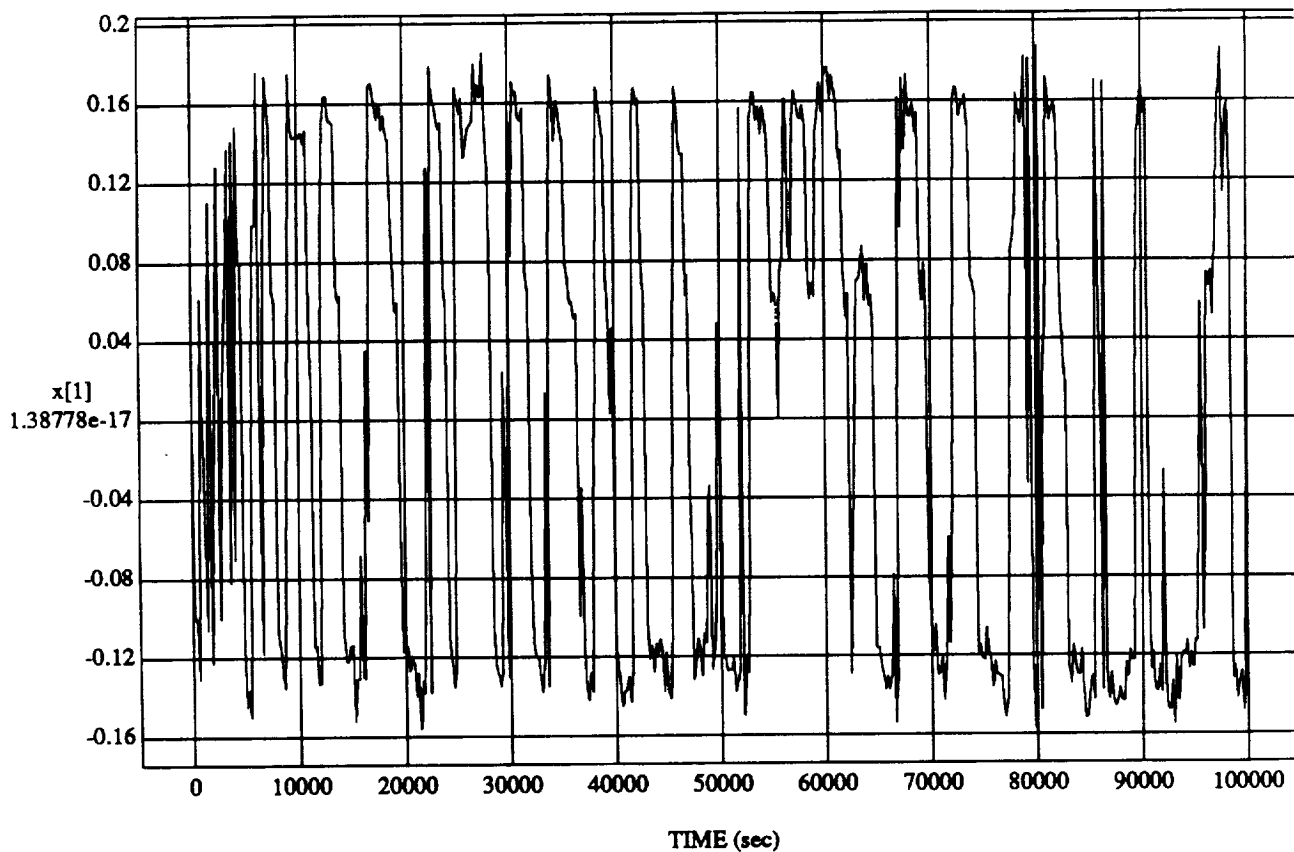
$x[0]$  vs TIME  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

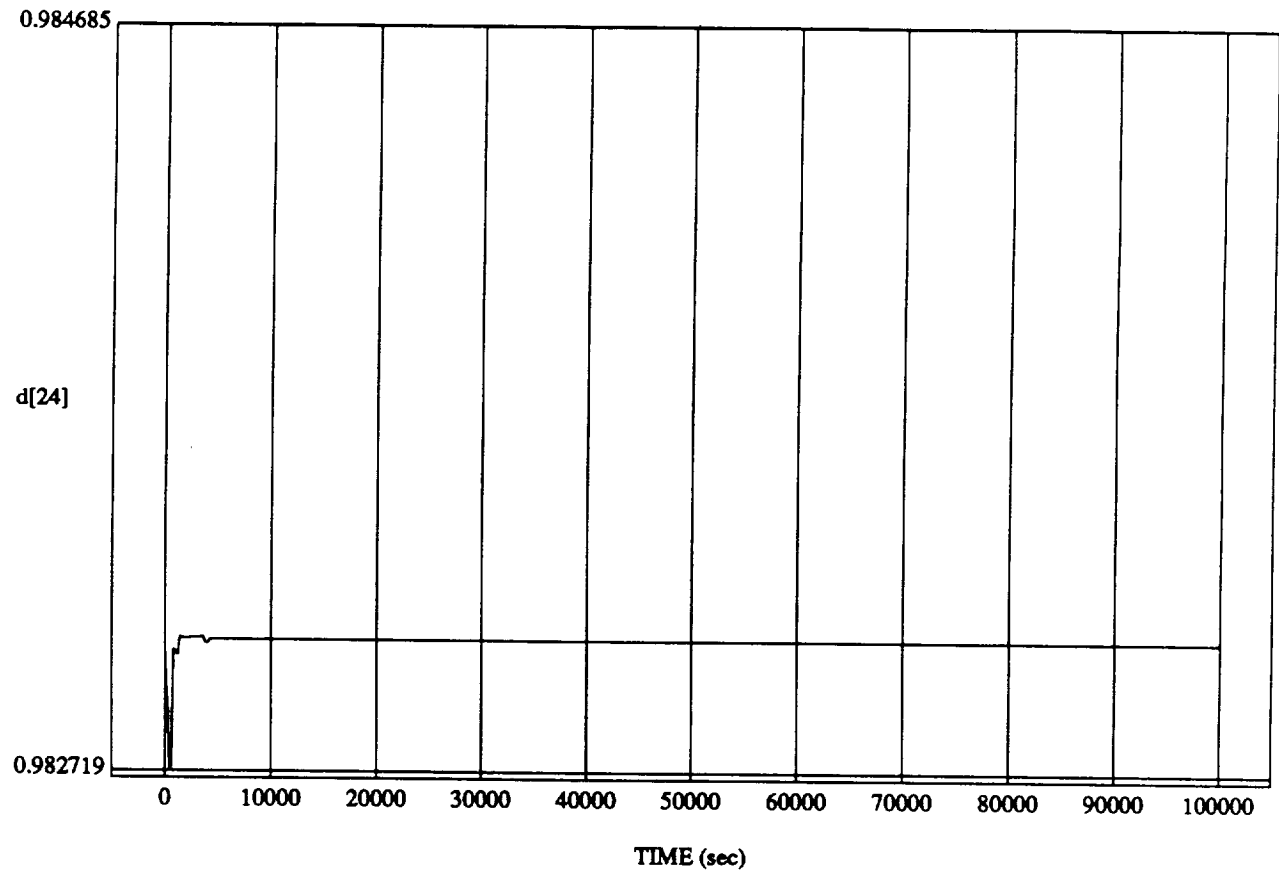
SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

$x[1]$  vs TIME  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.005 Hz

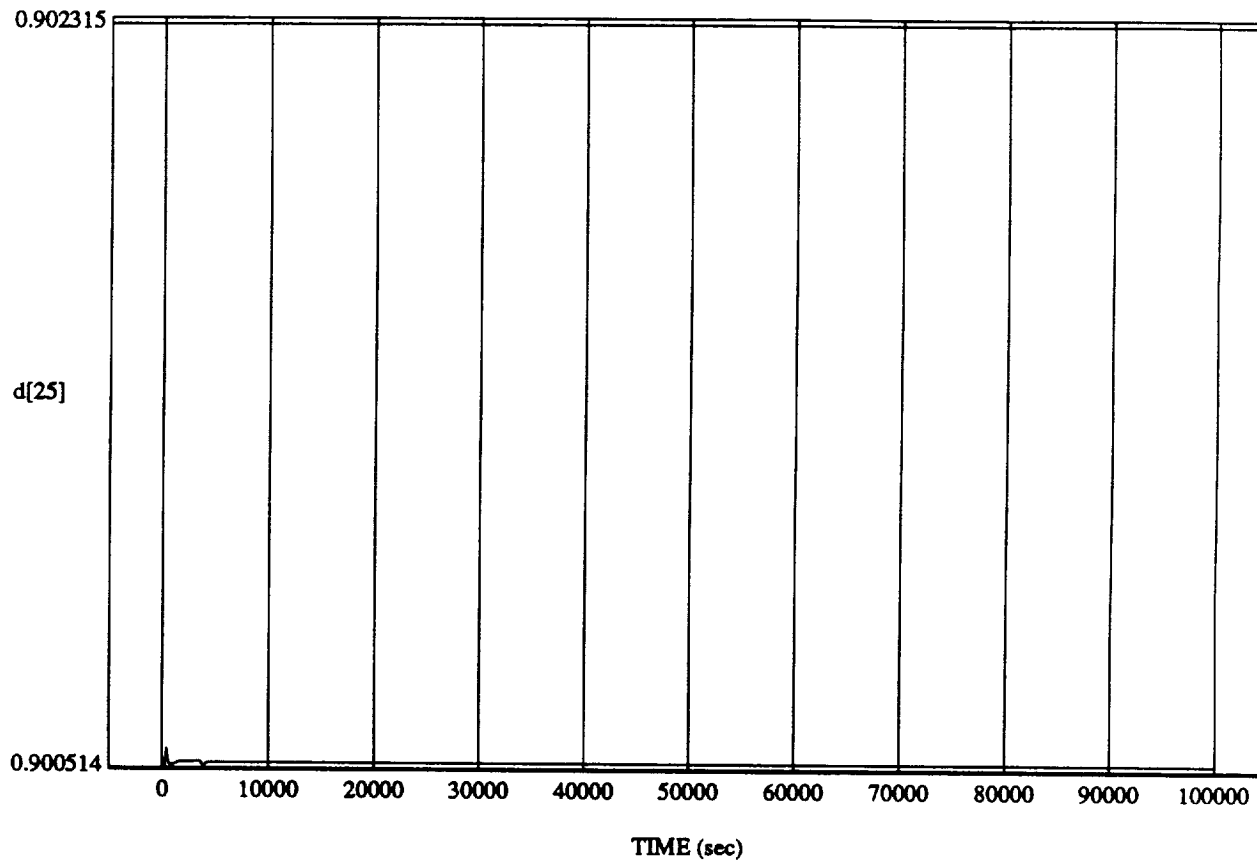
d[24] vs TIME  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

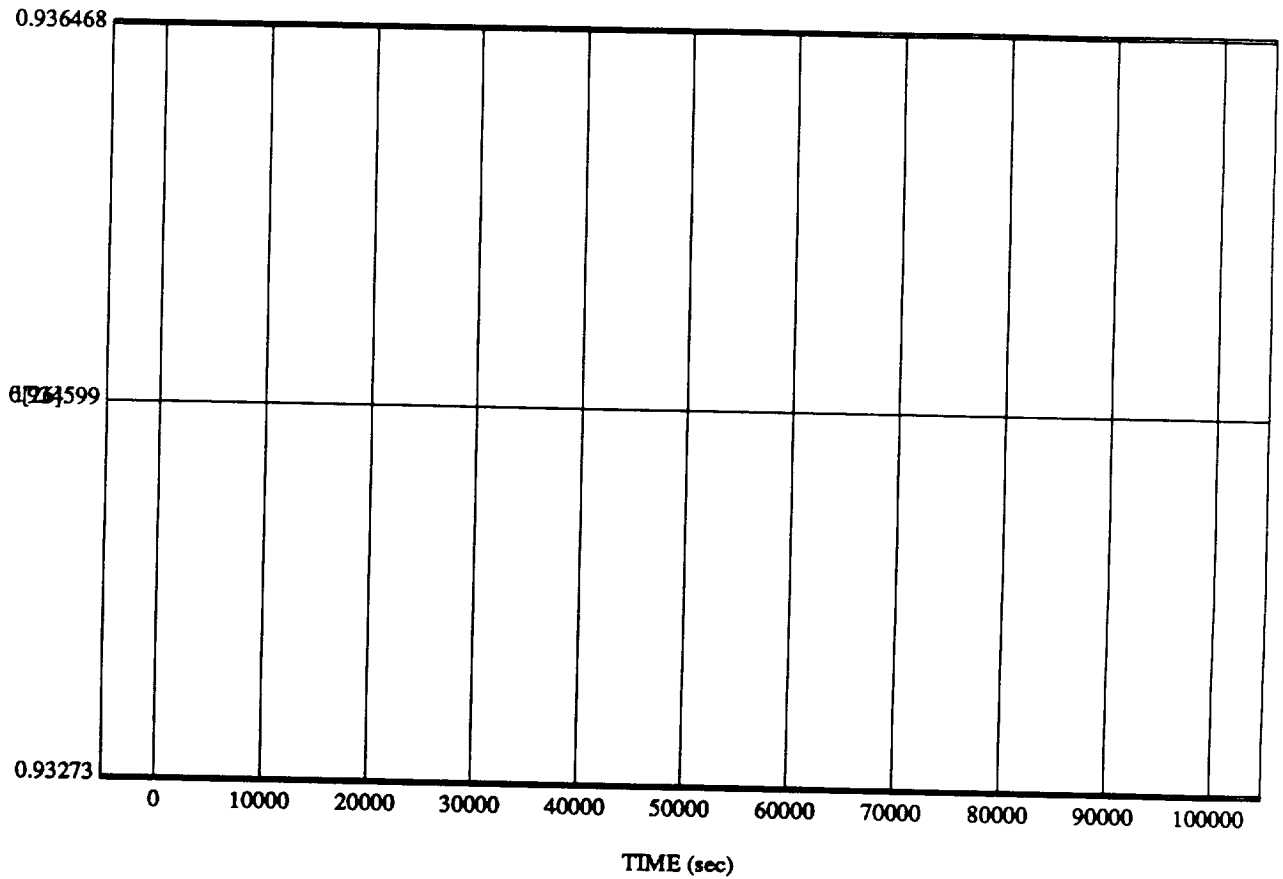
**d[25] vs TIME**  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

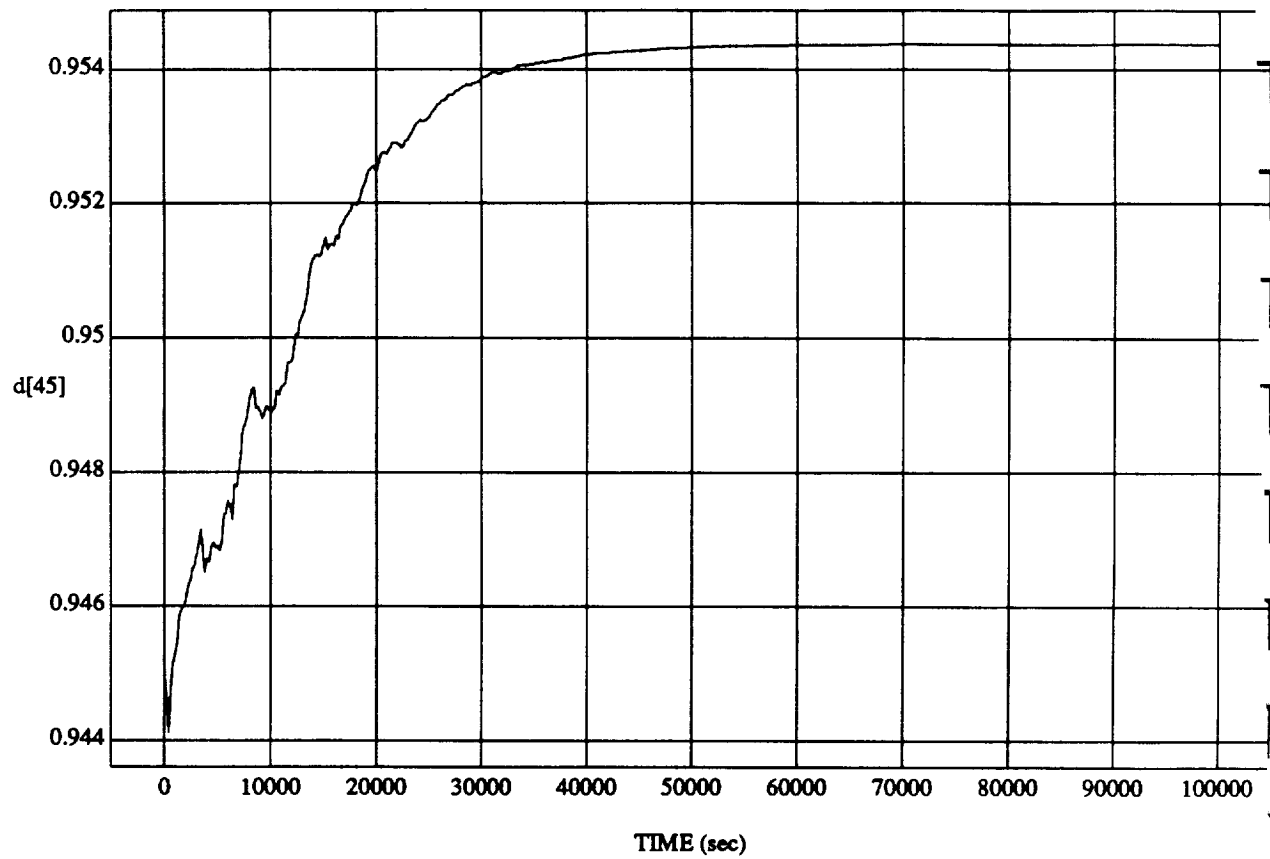
**d[26] vs TIME**  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

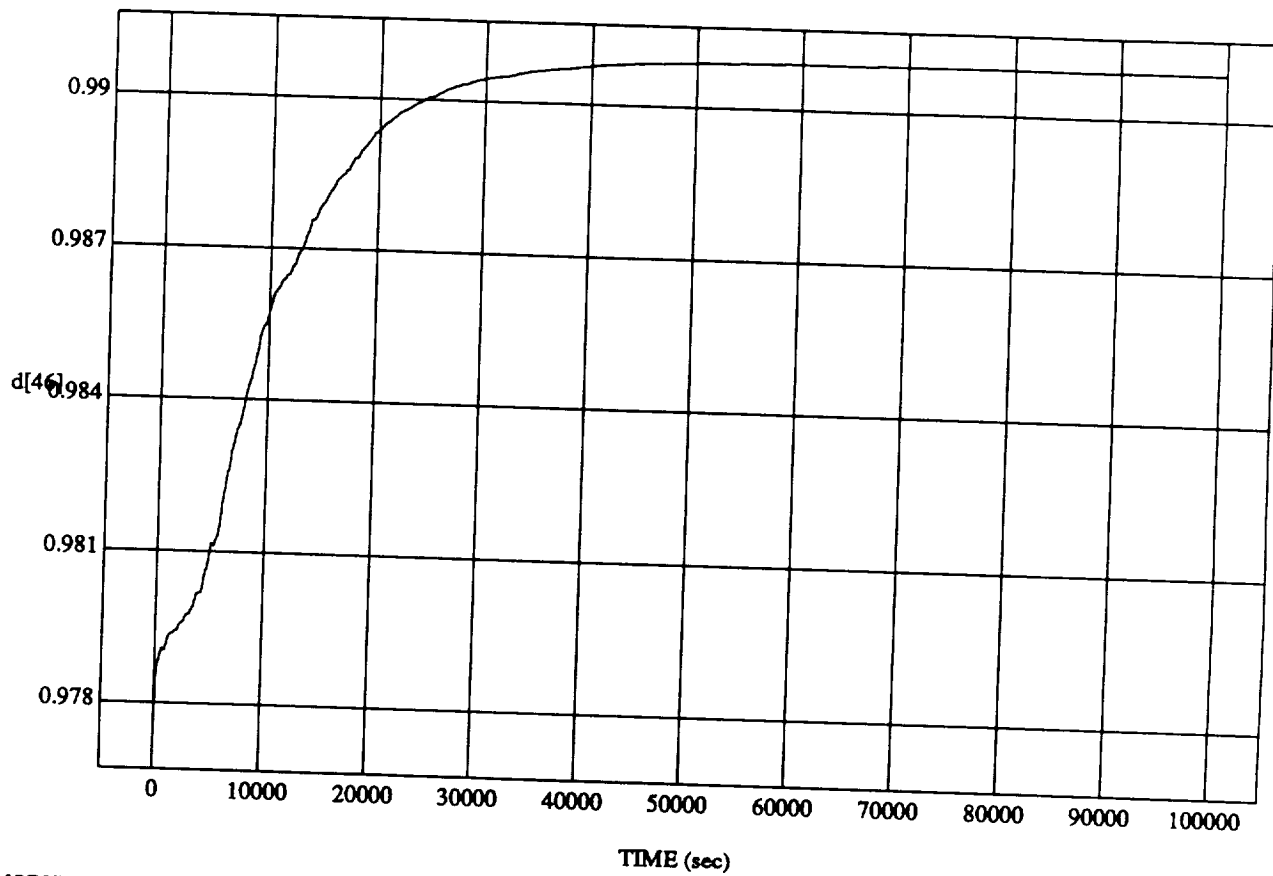
d[45] vs TIME  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

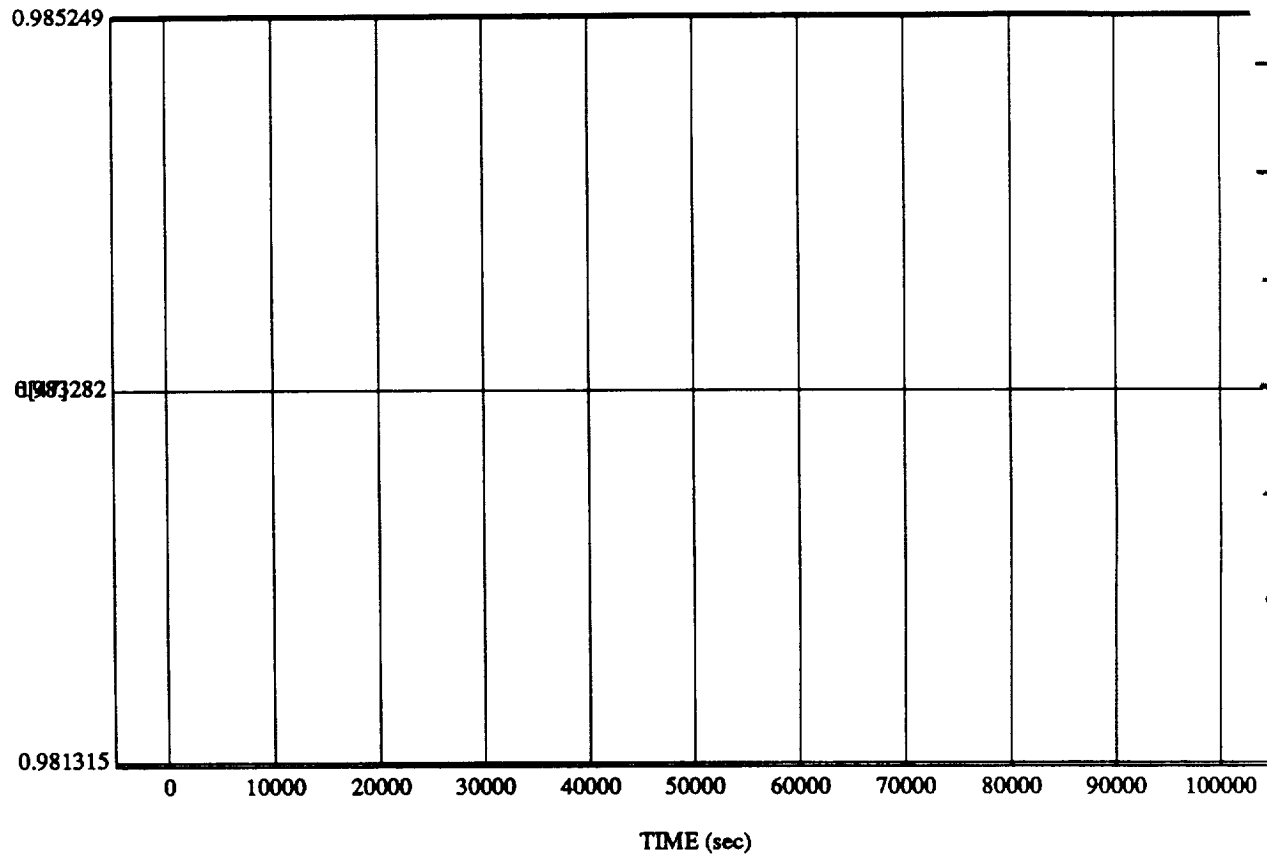
d[46] vs TIME  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

d[47] vs TIME  
RUN: 45 Degree Pitch Attitude Hold

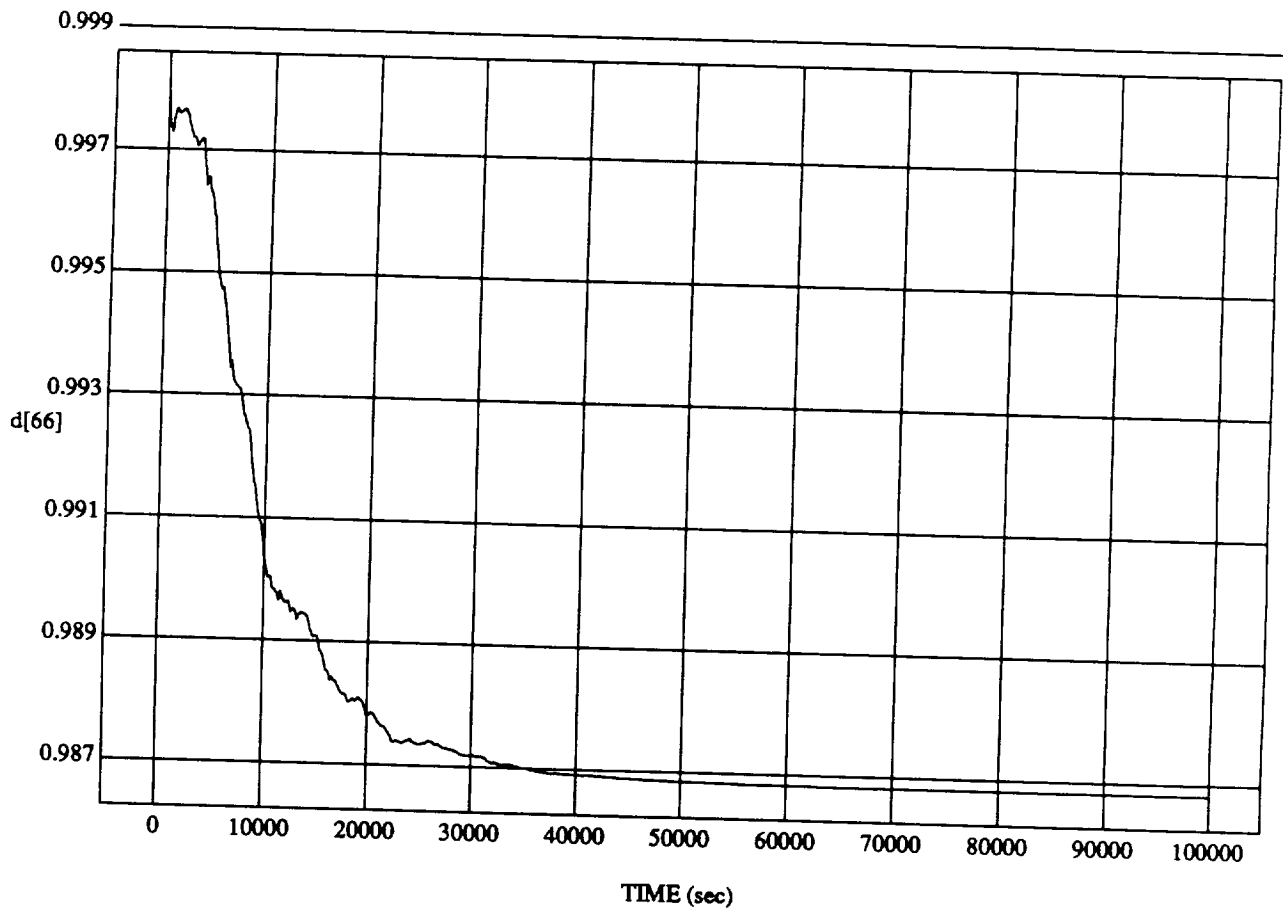


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

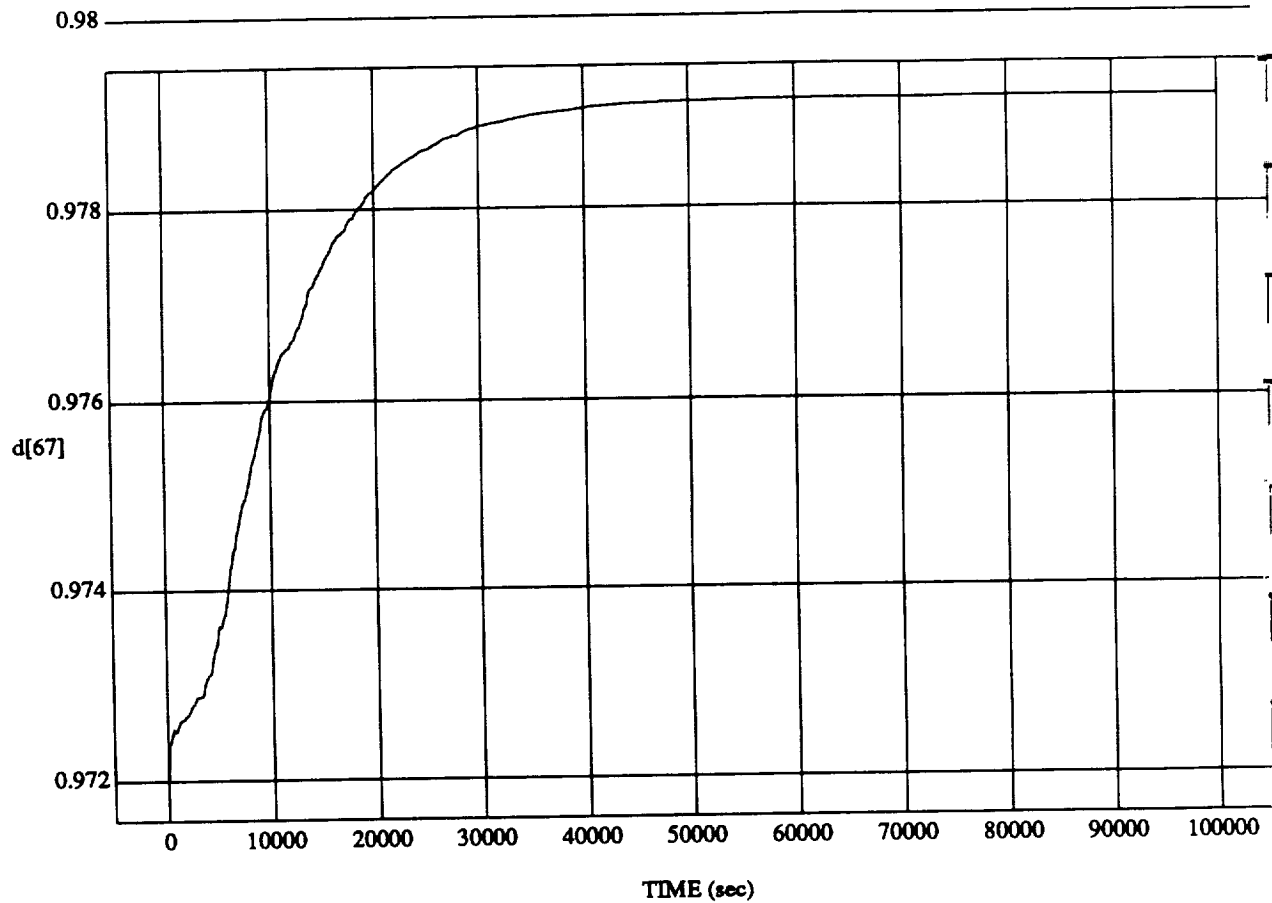
**d[66] vs TIME**  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

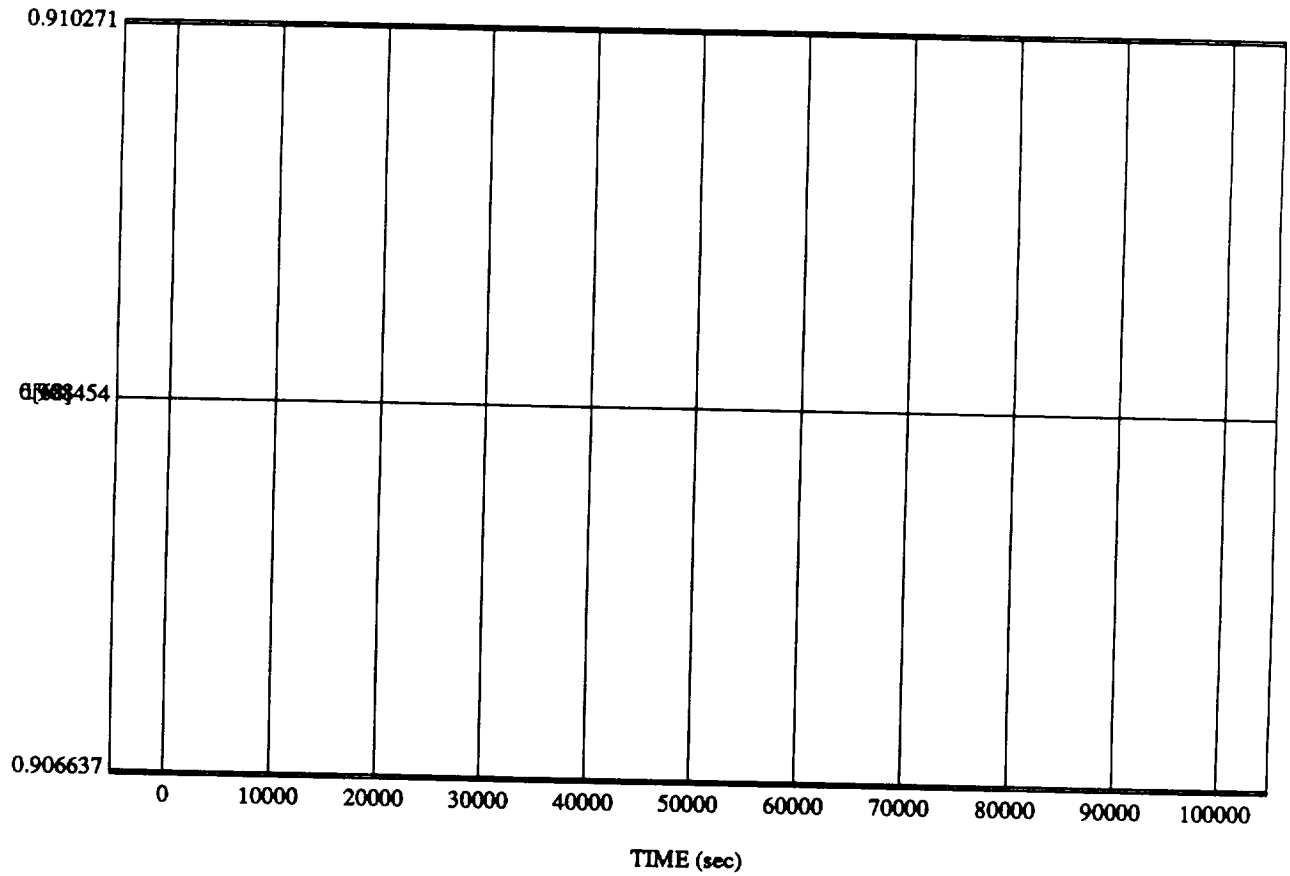
d[67] vs TIME  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

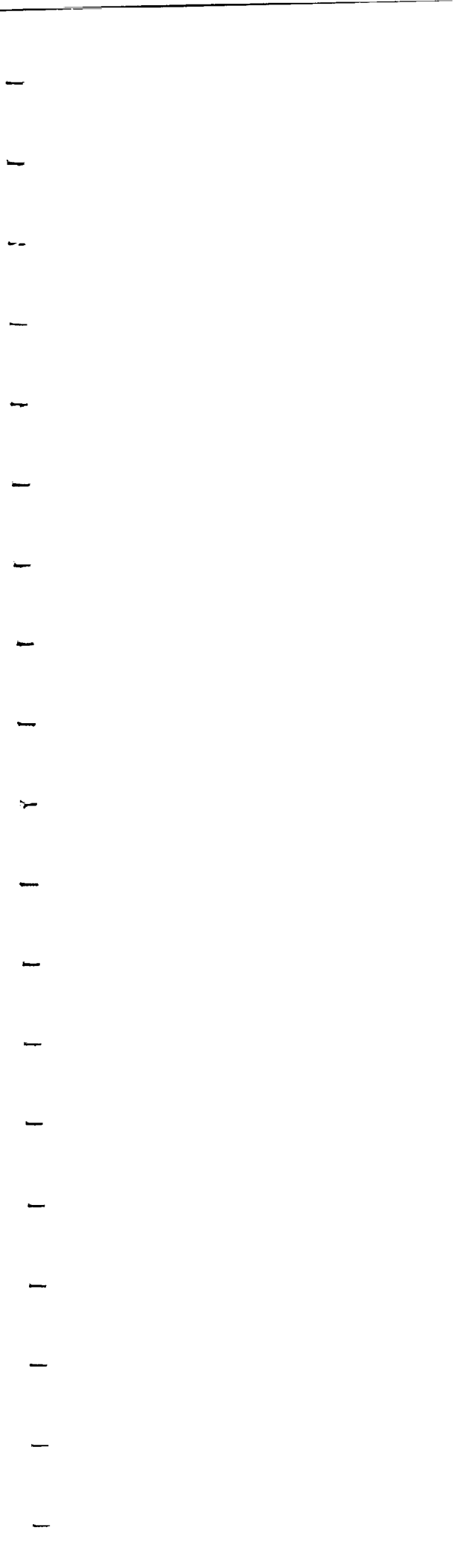
SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

d[68] vs TIME  
RUN: 45 Degree Pitch Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz



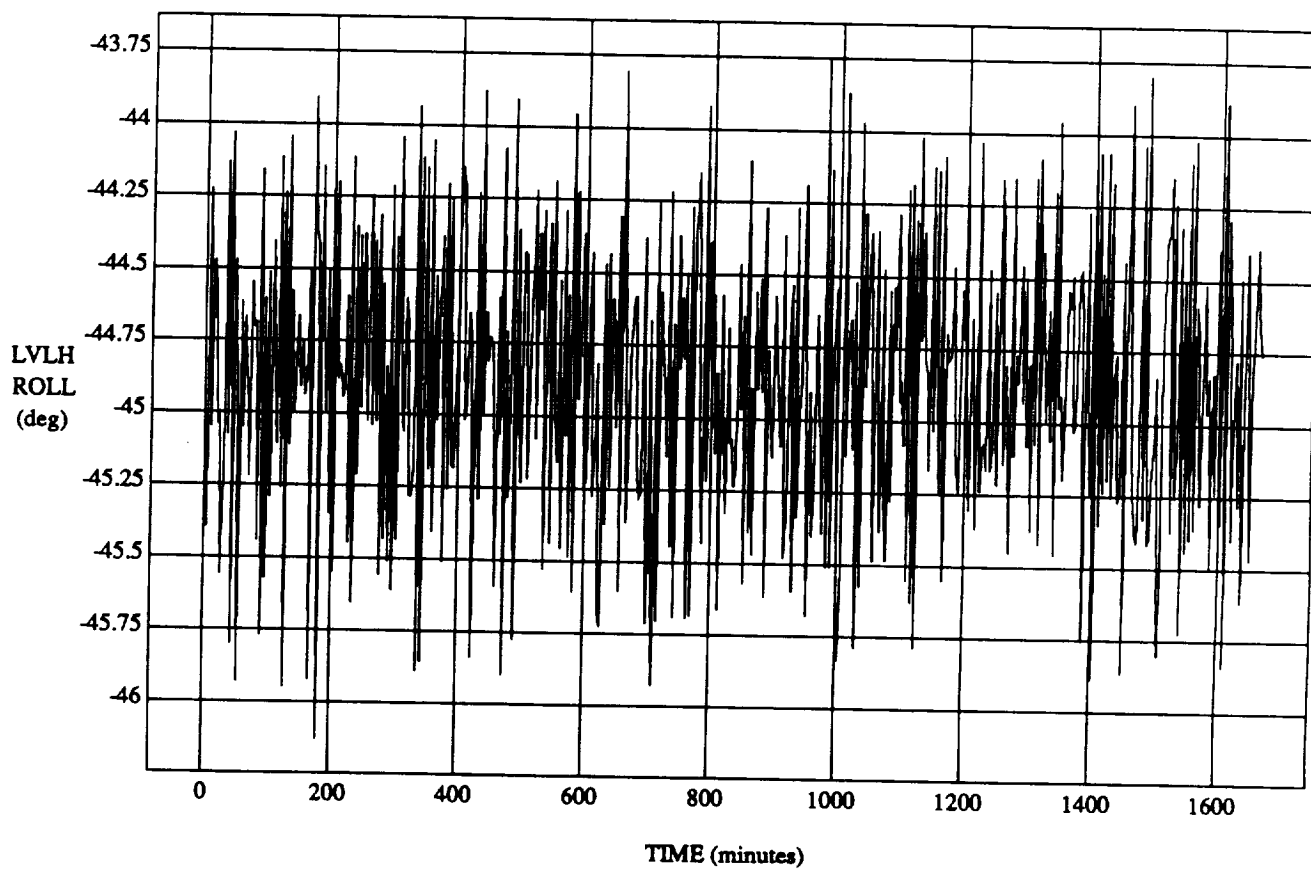




SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

LVLH EULER PYR ROLL vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

XVI  
zone is XV  
but different  
IC

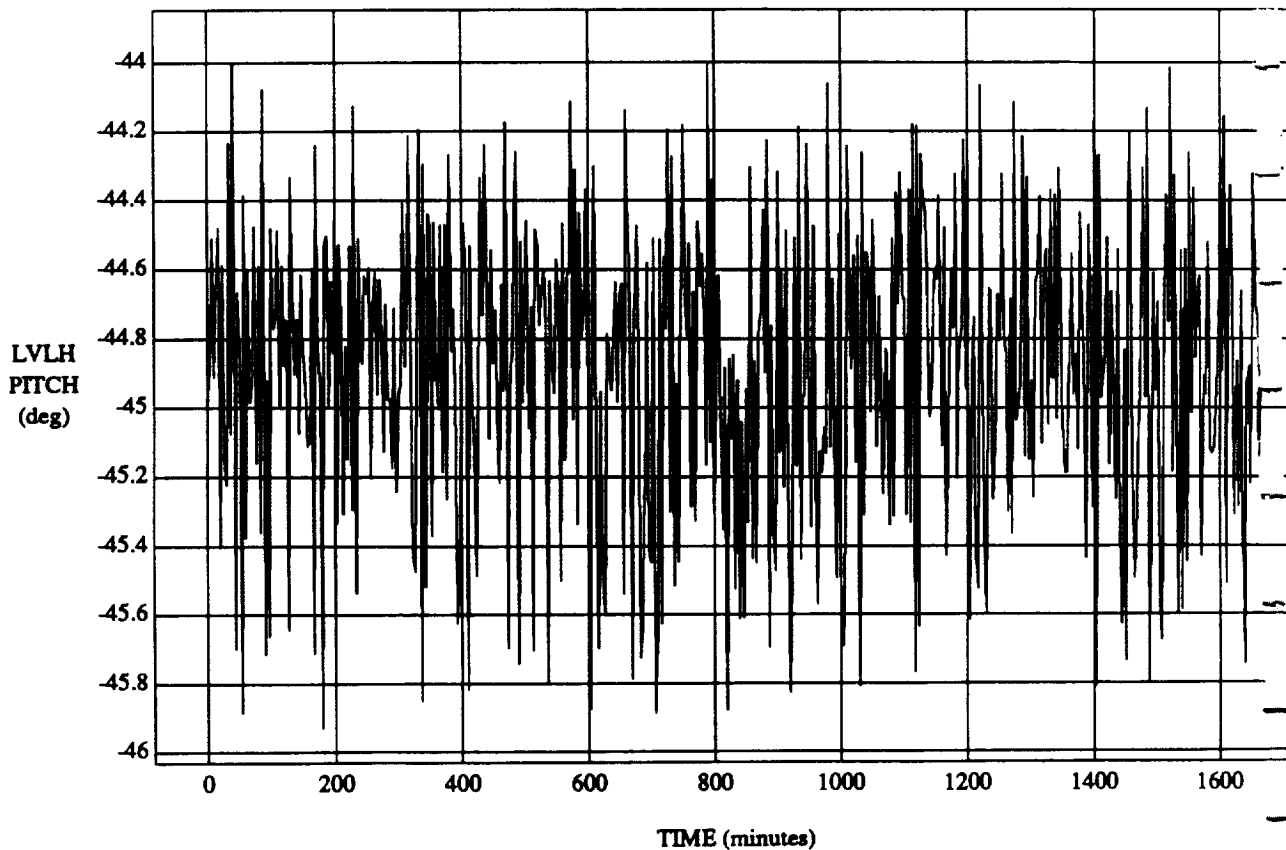


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

### LVLH EULER PYR PITCH vs TIME

RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

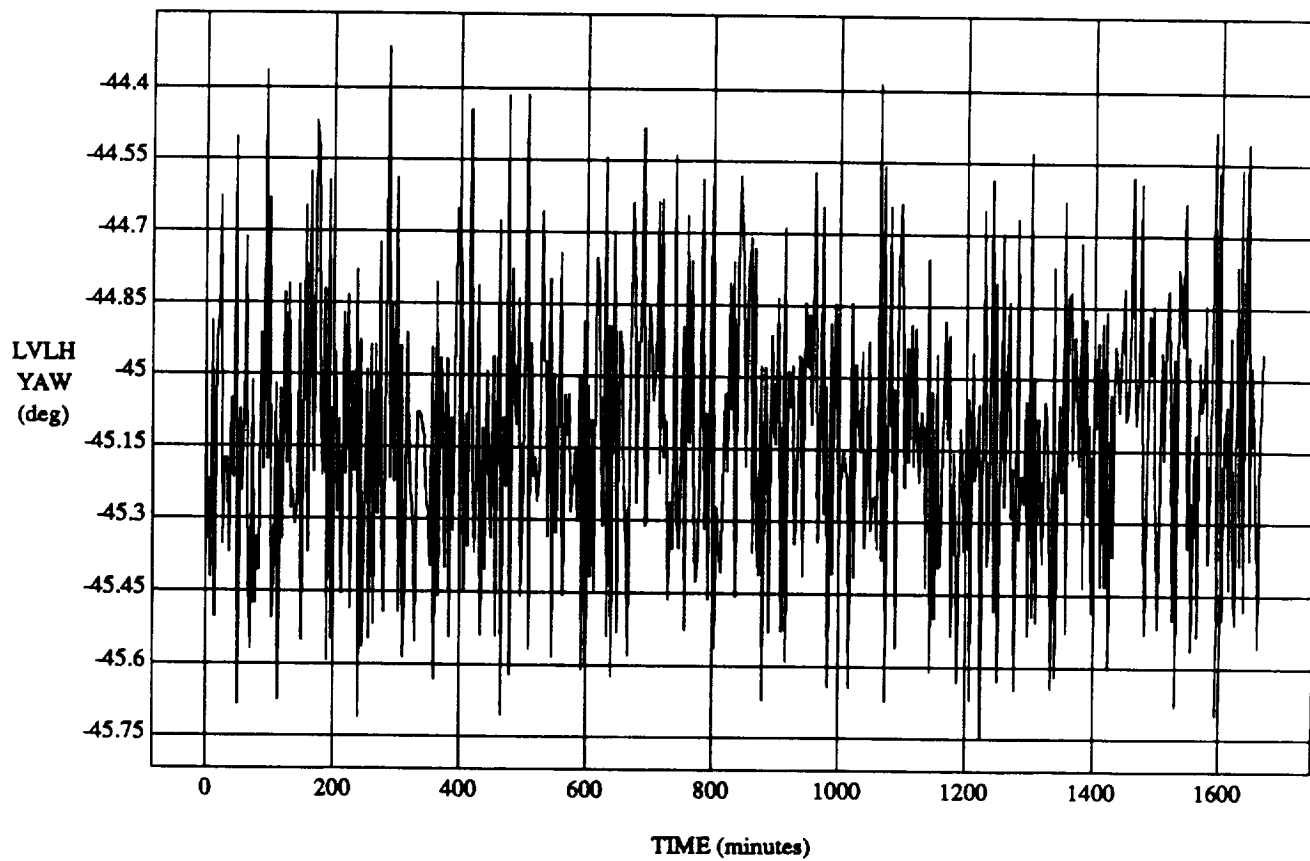


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

**LVLH EULER PYR YAW vs TIME**  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

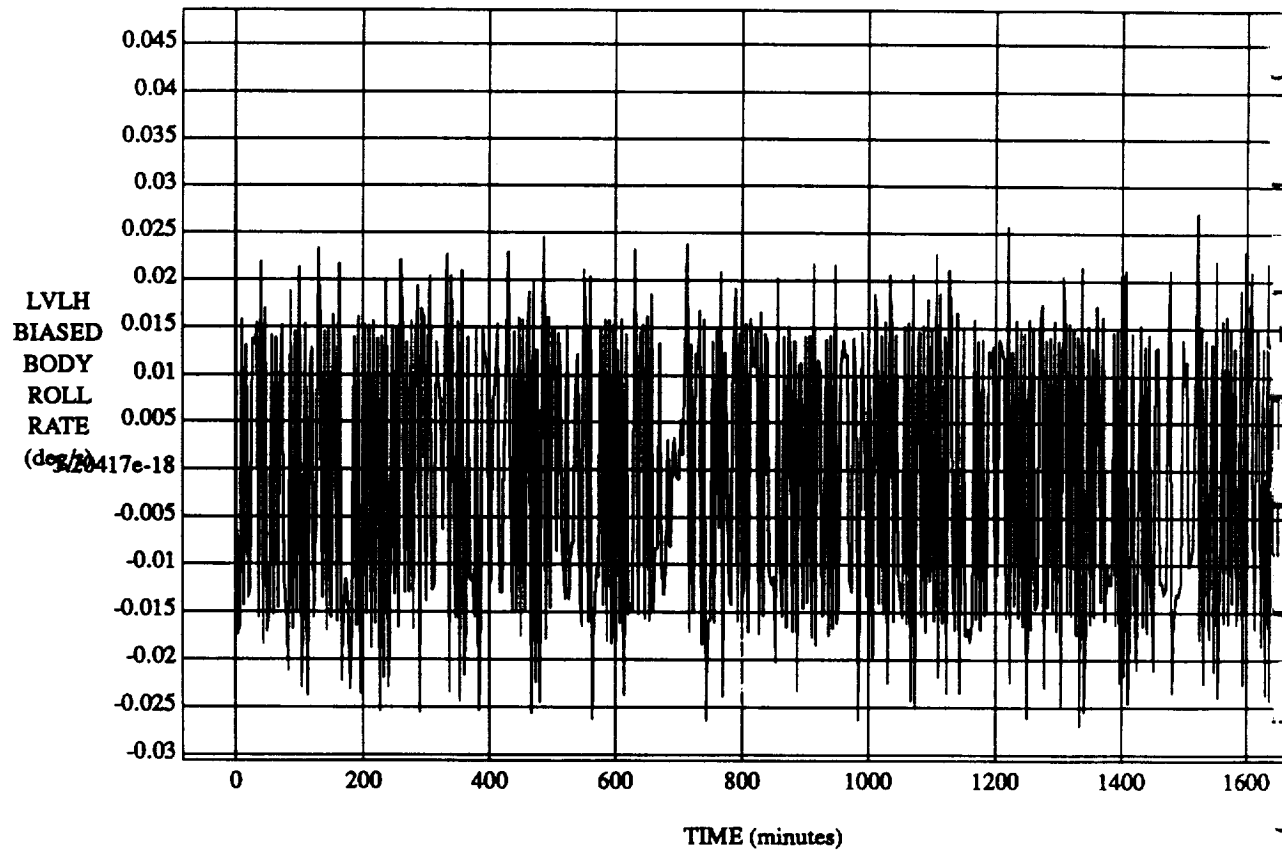


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

### LVLH BIASED BODY ROLL RATE vs TIME

RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



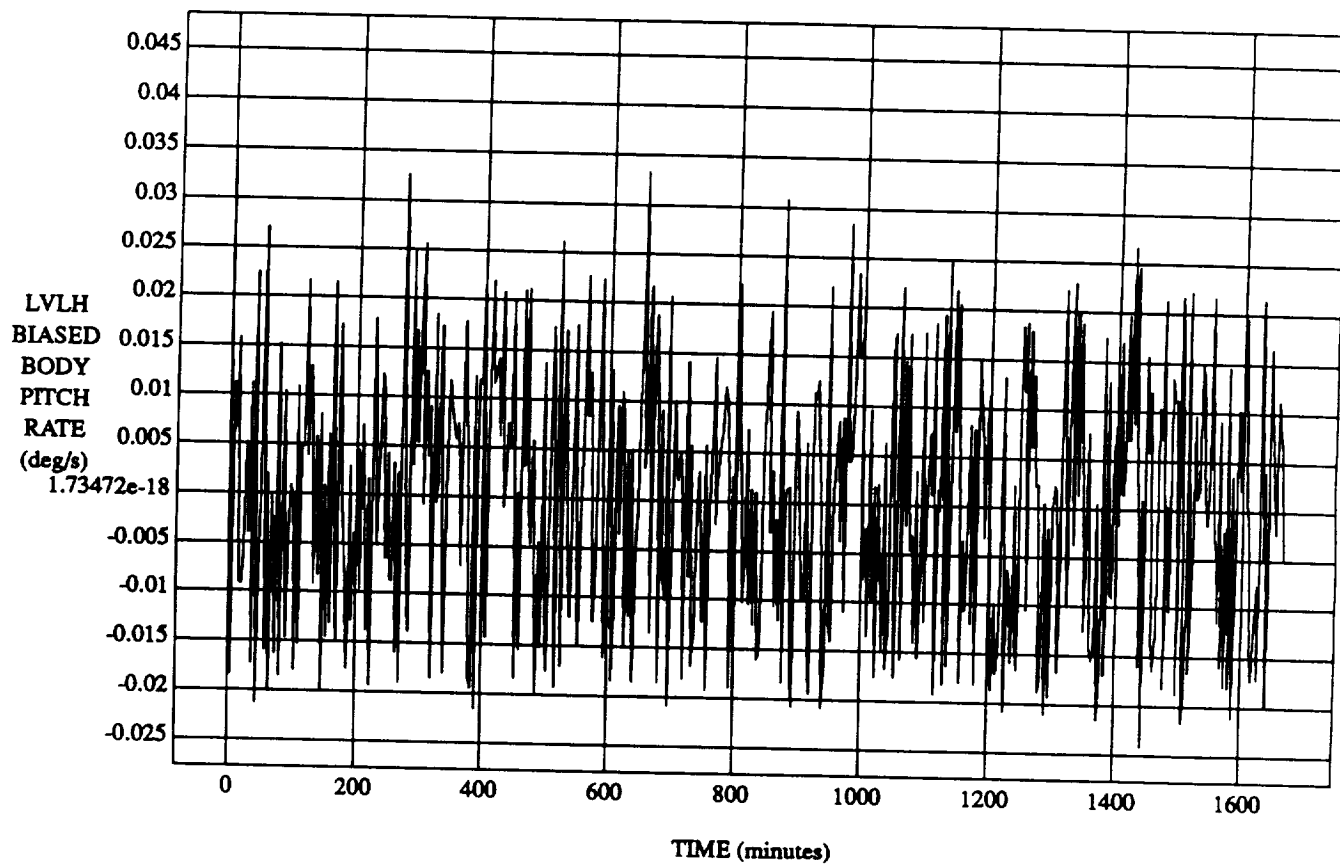
VEHICLE: ORB\_FUZZ\_BATCH.state

DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

### LVLH BIASED BODY PITCH RATE vs TIME

RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



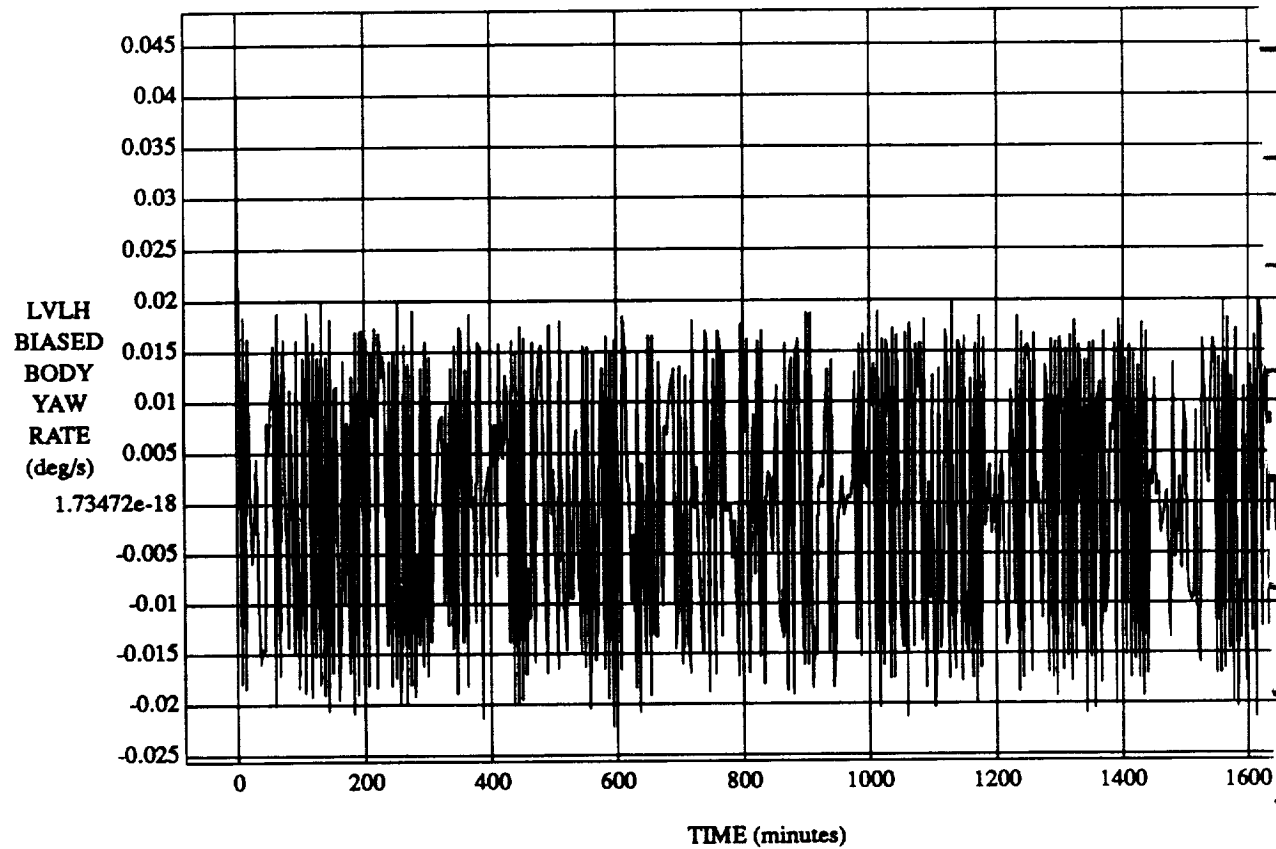
VEHICLE: ORB\_FUZZ\_BATCH.state

DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

### LVLH BIASED BODY YAW RATE vs TIME

RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

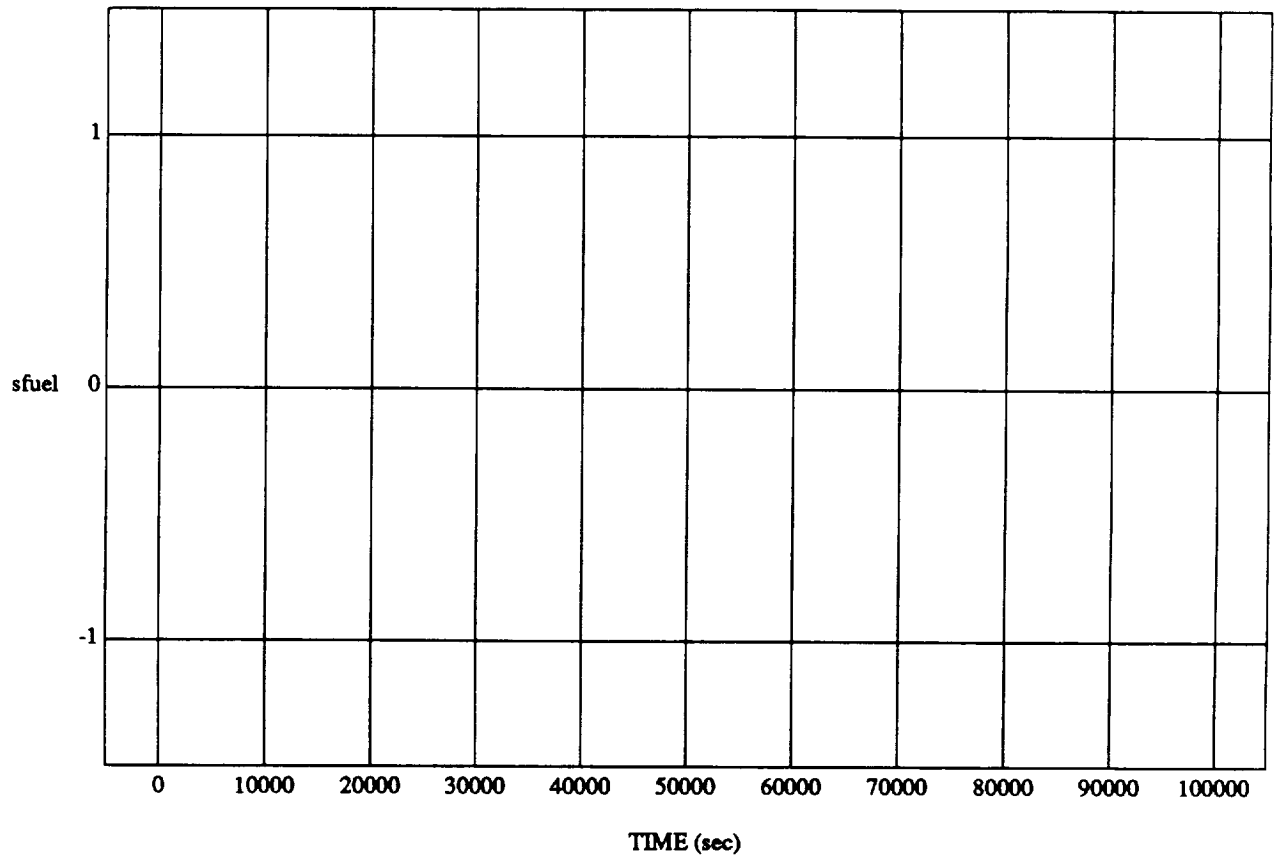


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

### sfuel vs TIME

RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

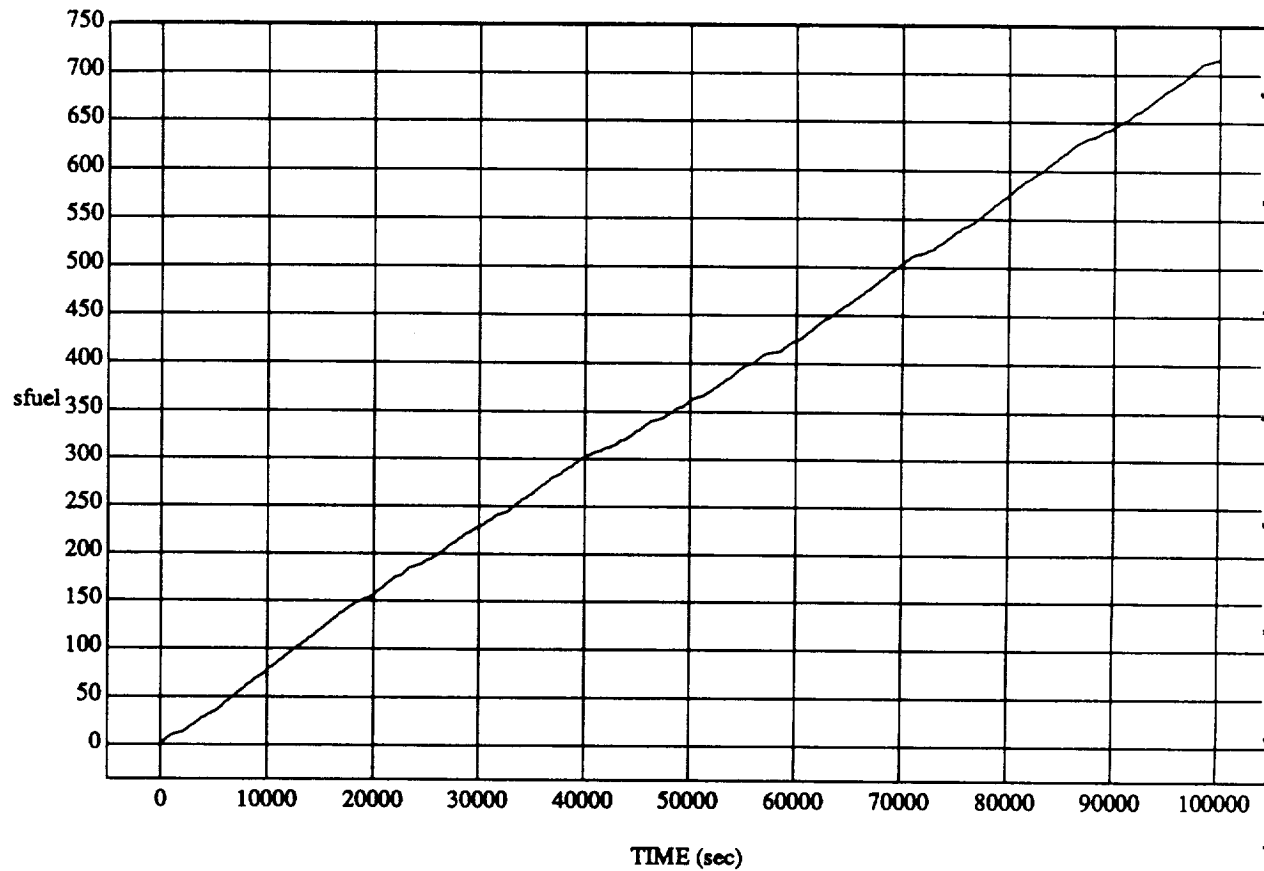


MODULE: ORB\_FUZZ\_BATCH.primary  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

### sfuel vs TIME

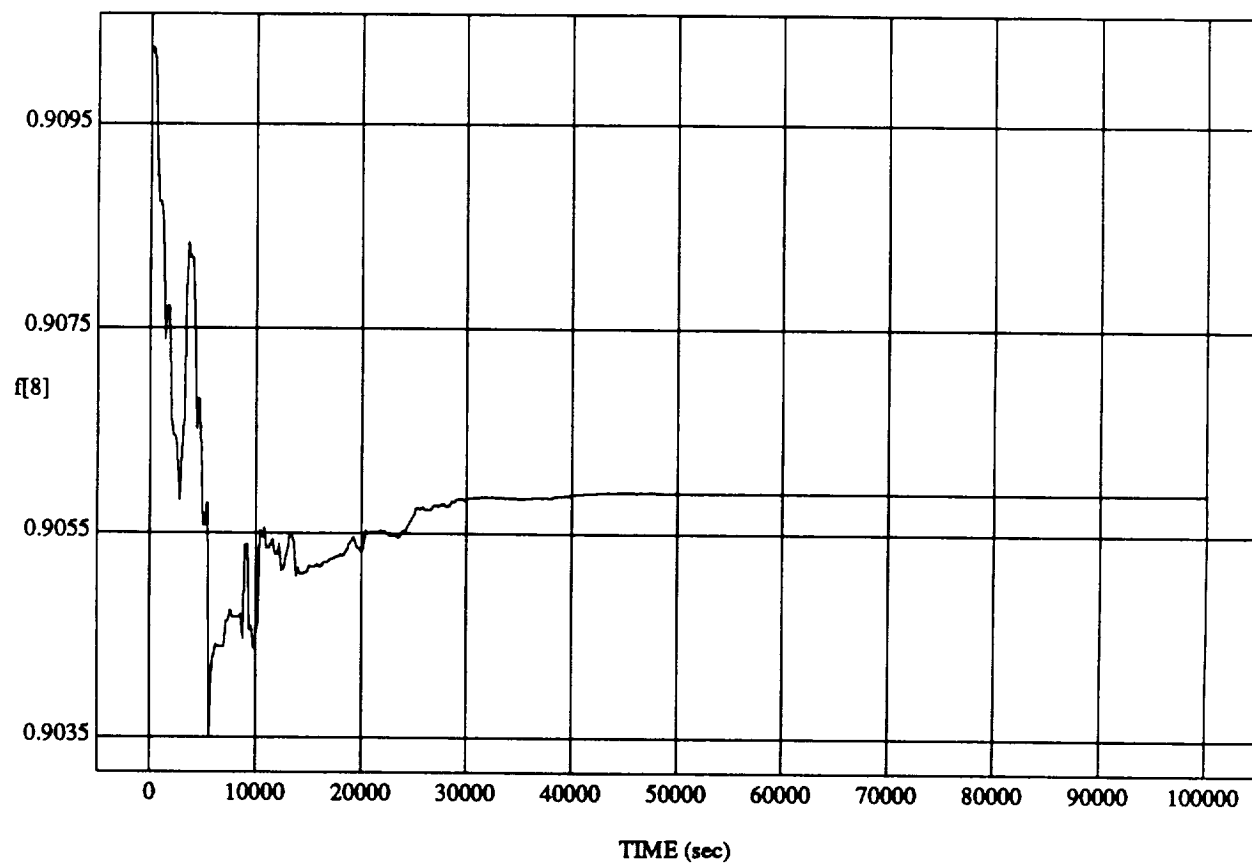
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

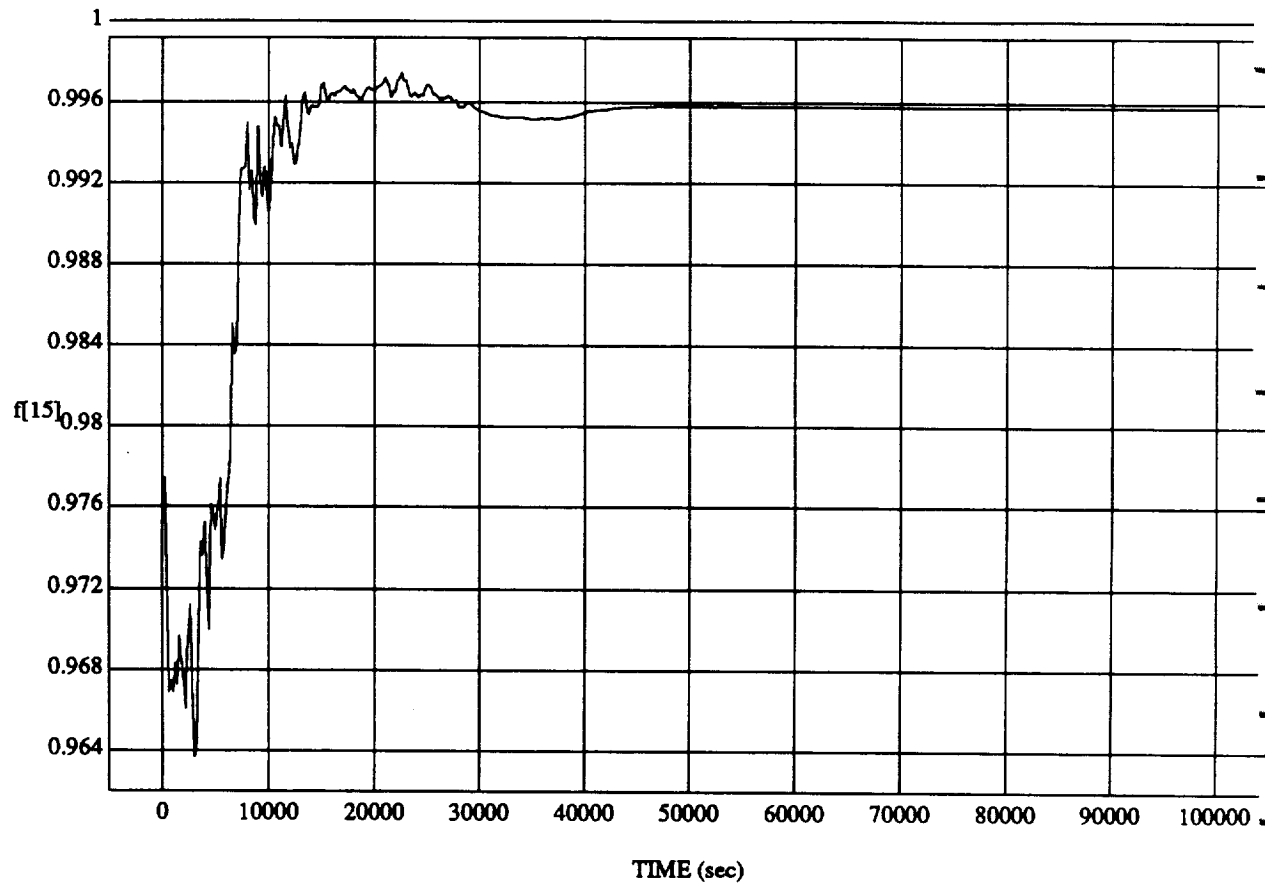
**f[8] vs TIME**  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

**f[15] vs TIME**  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

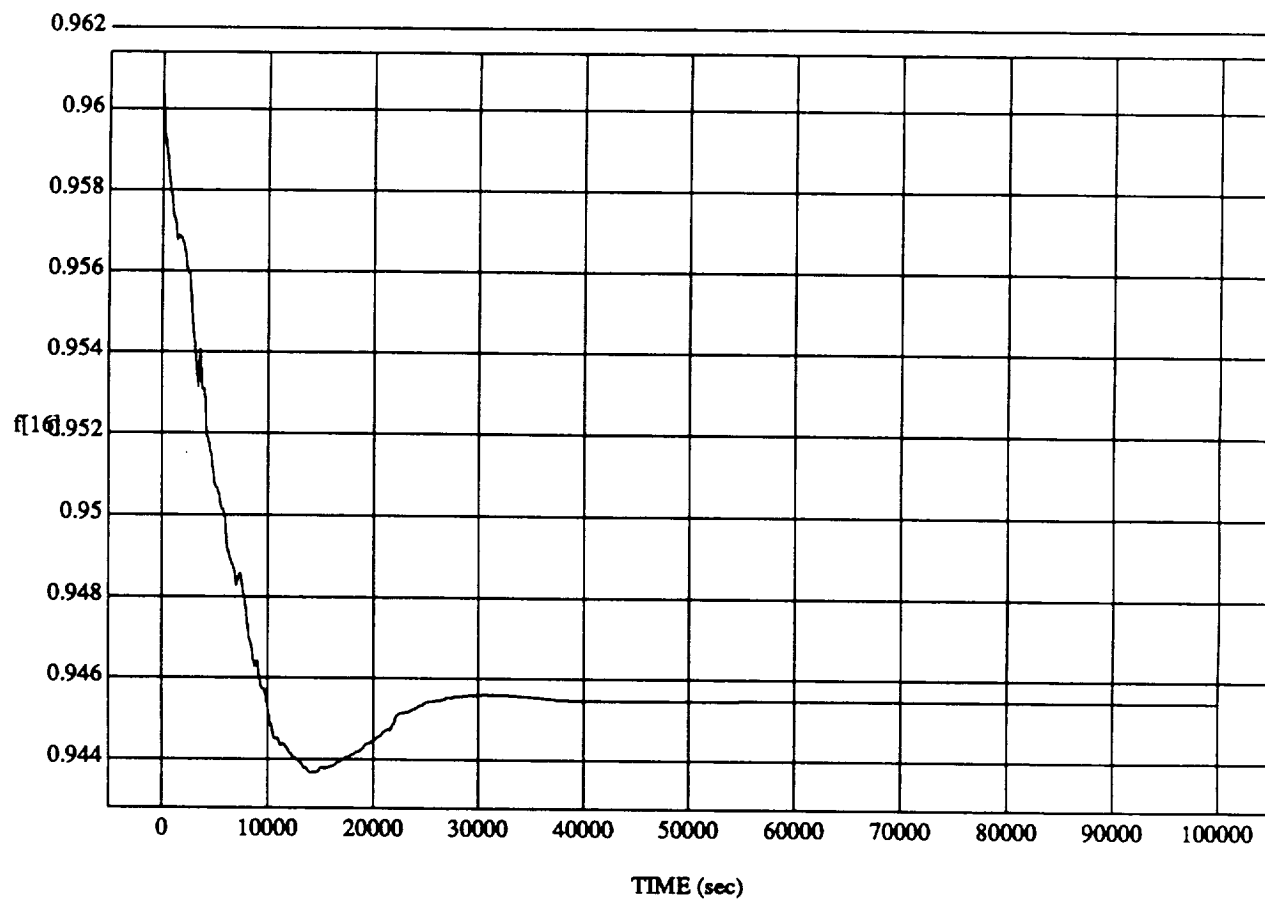


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

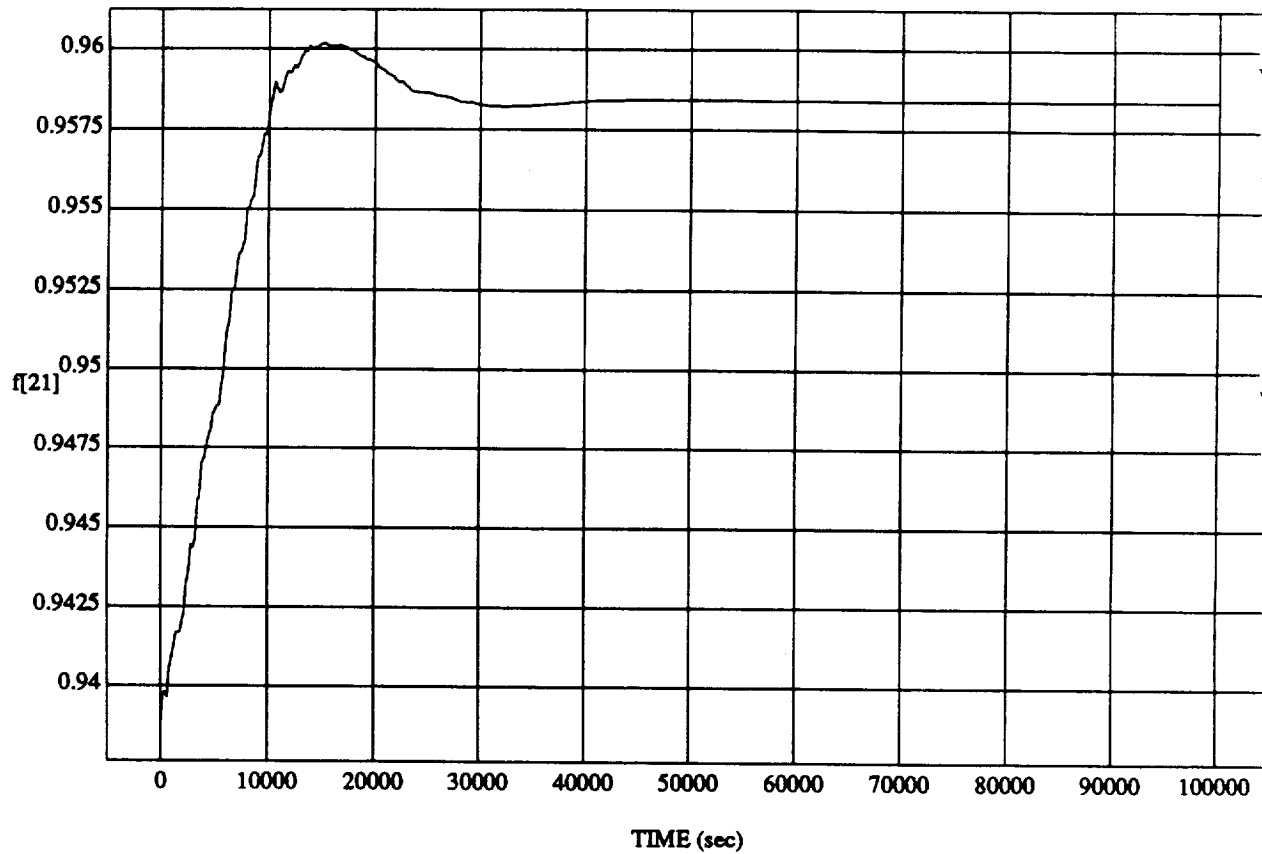
$f[16]$  vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

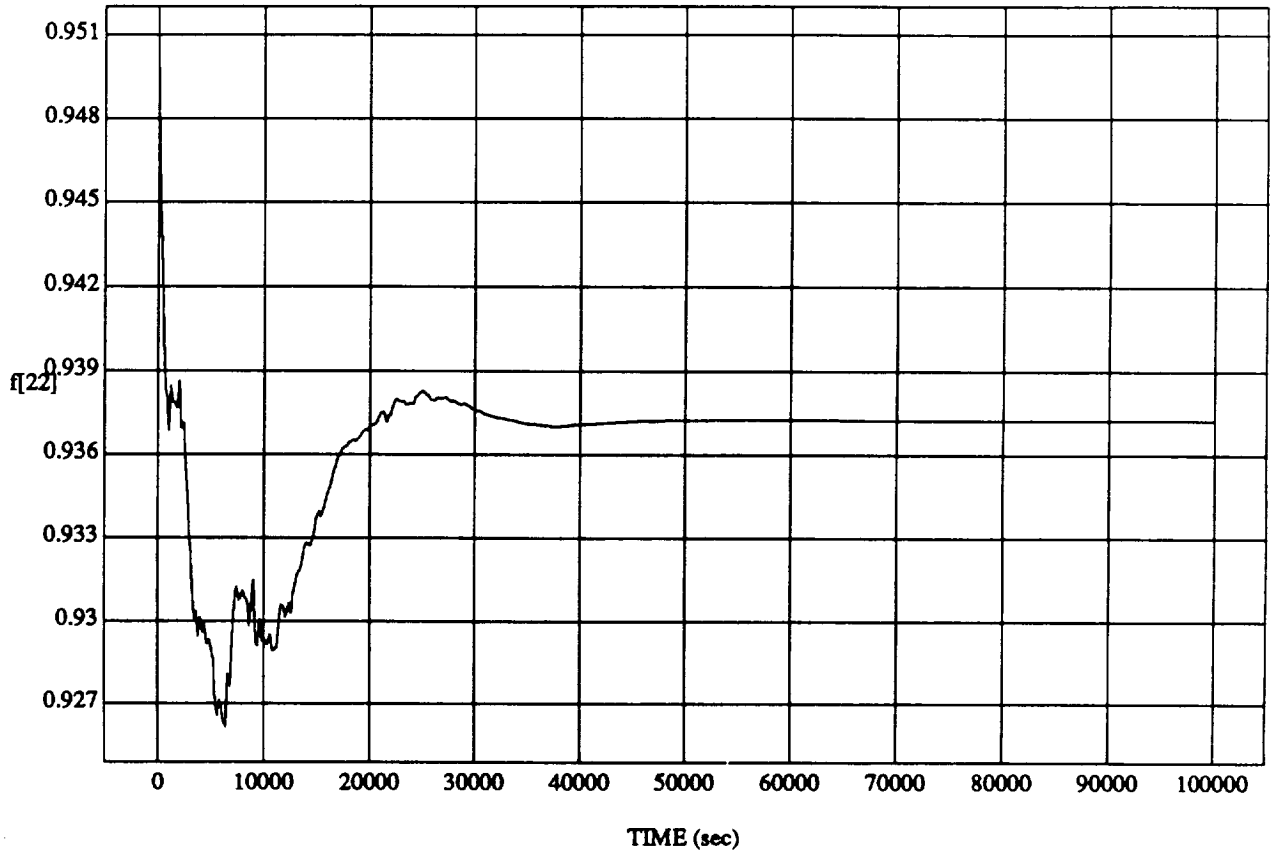
$f[21]$  vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

**f[22] vs TIME**  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

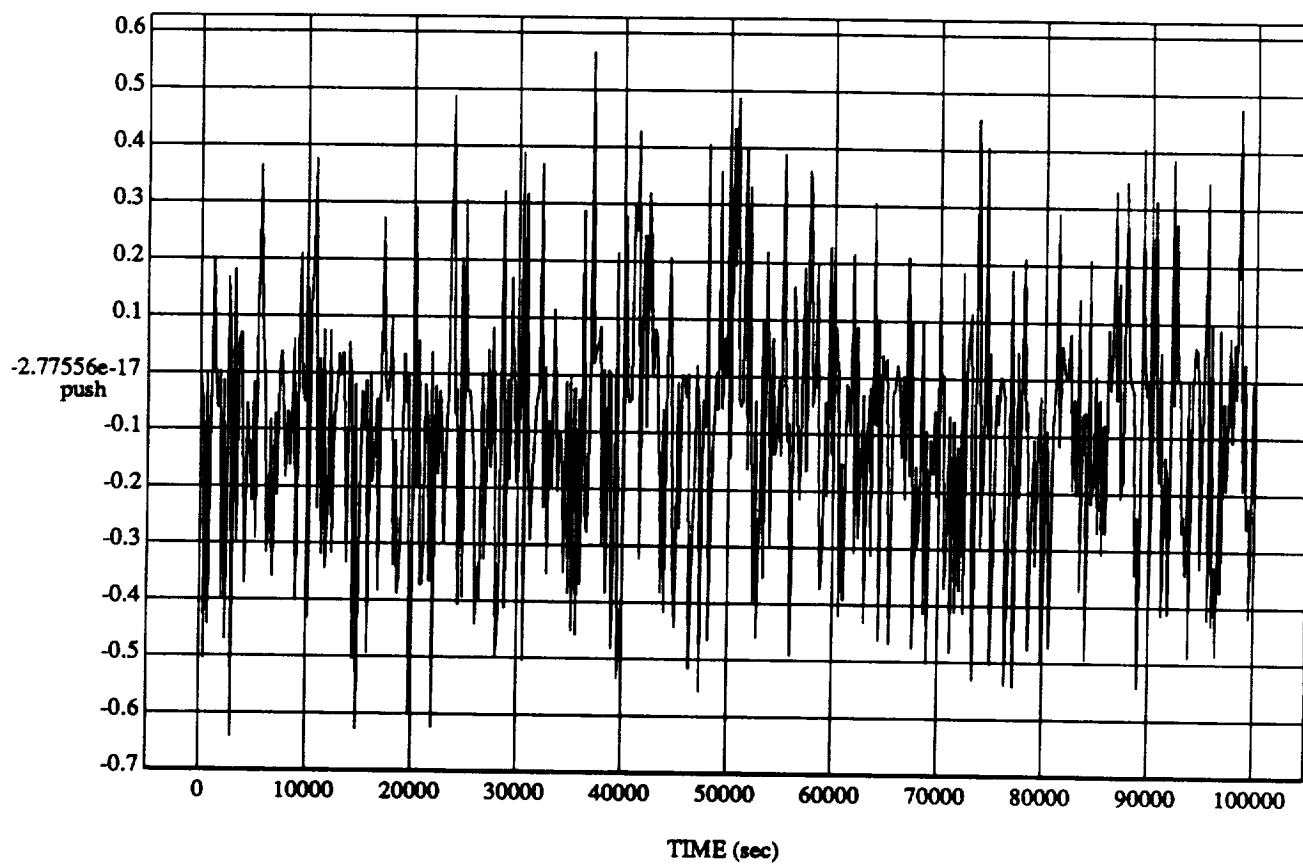


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

### push vs TIME

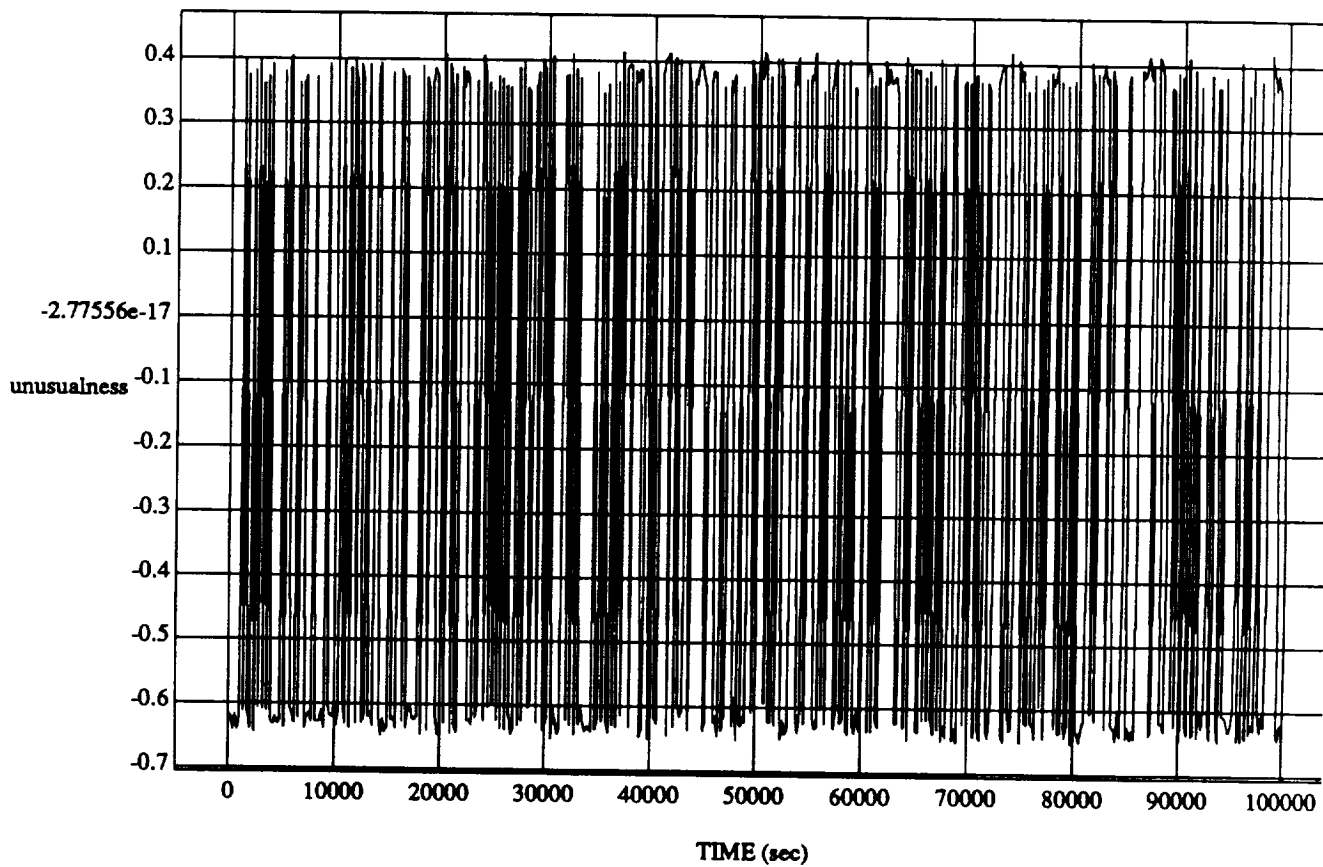
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

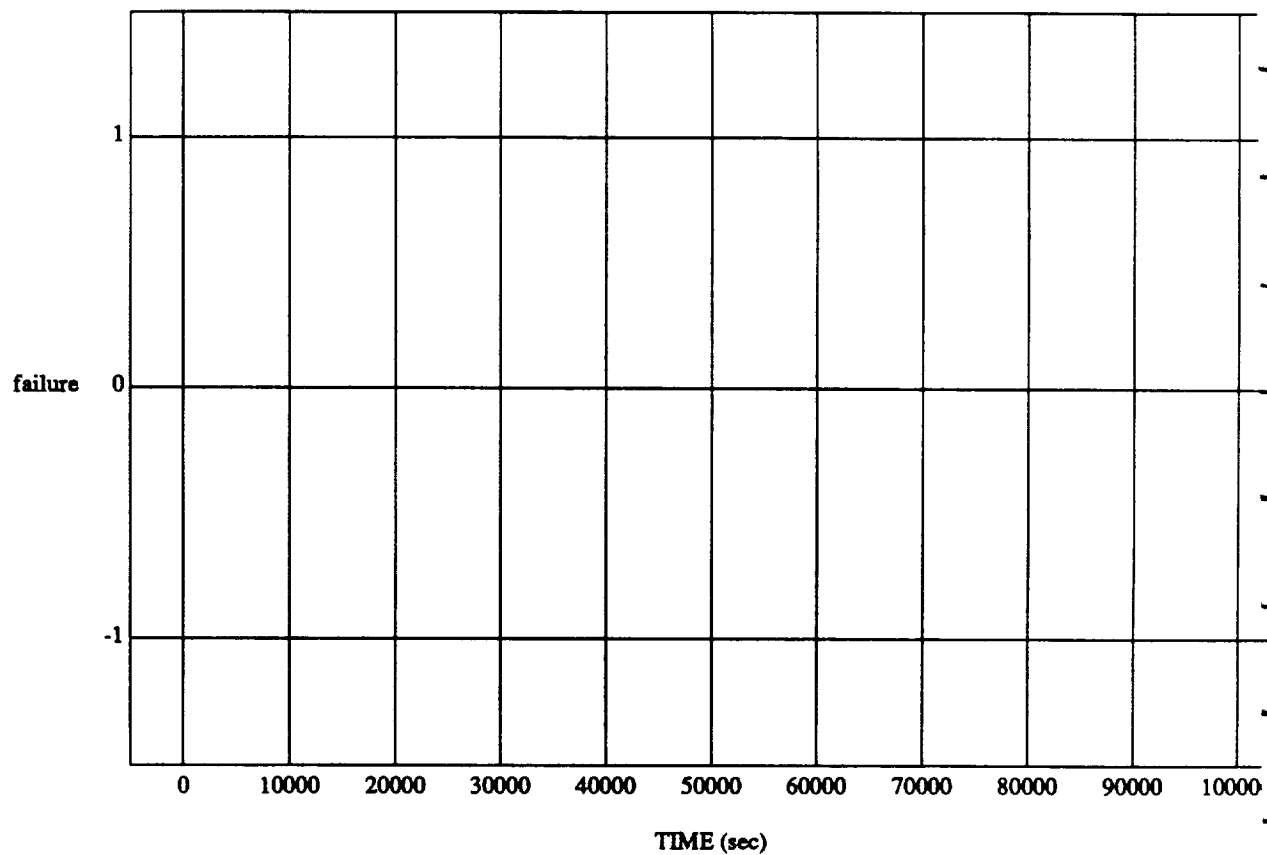
unusualness vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

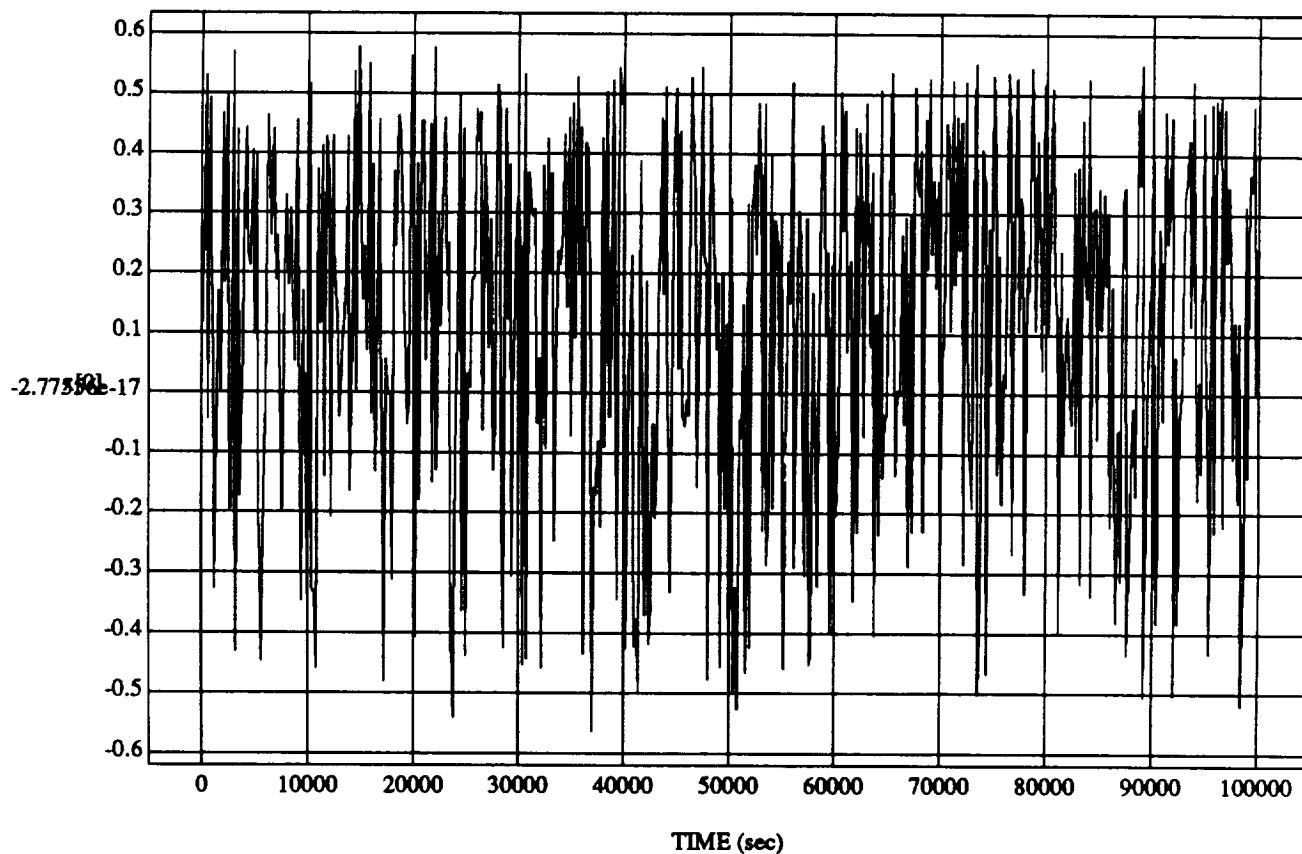
**failure vs TIME**  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

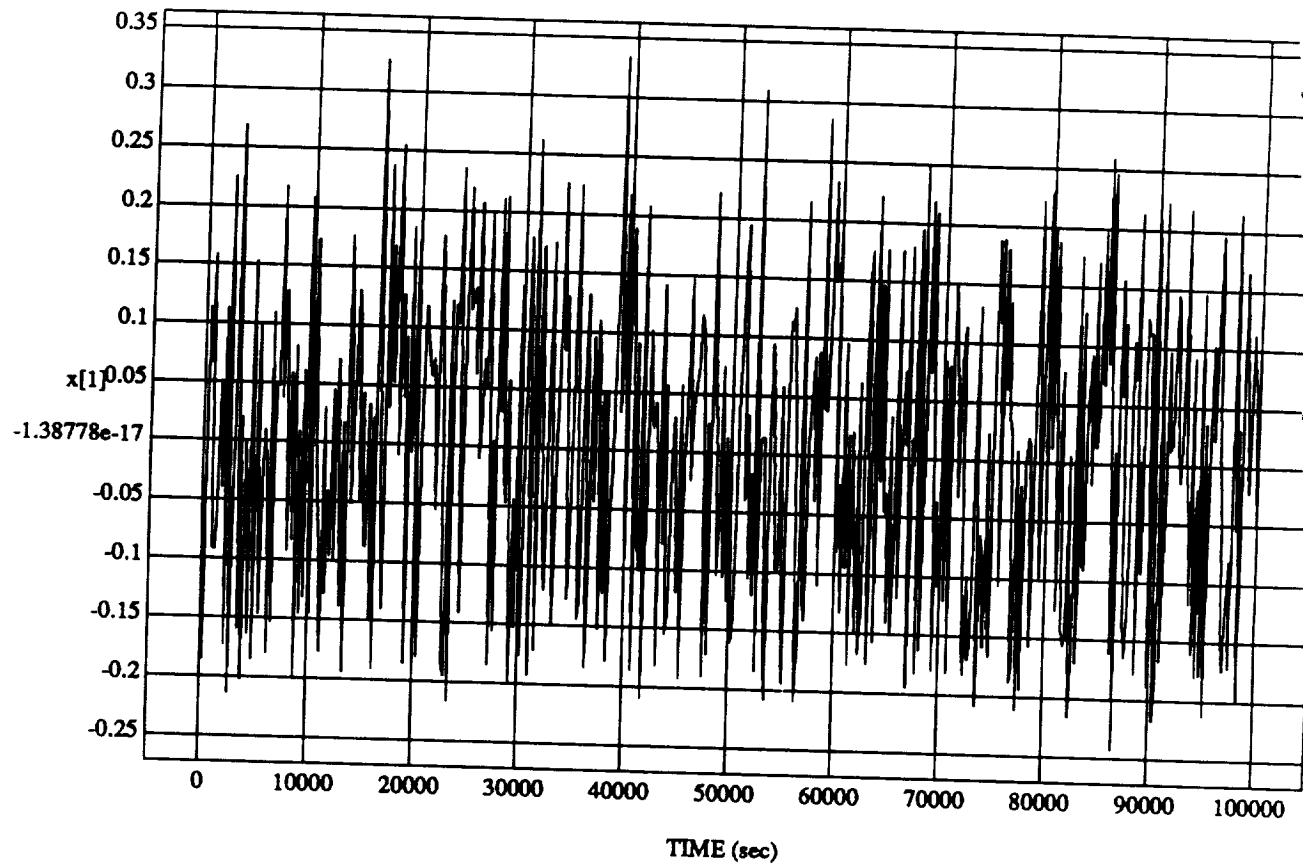
$x[0]$  vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

$x[1]$  vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

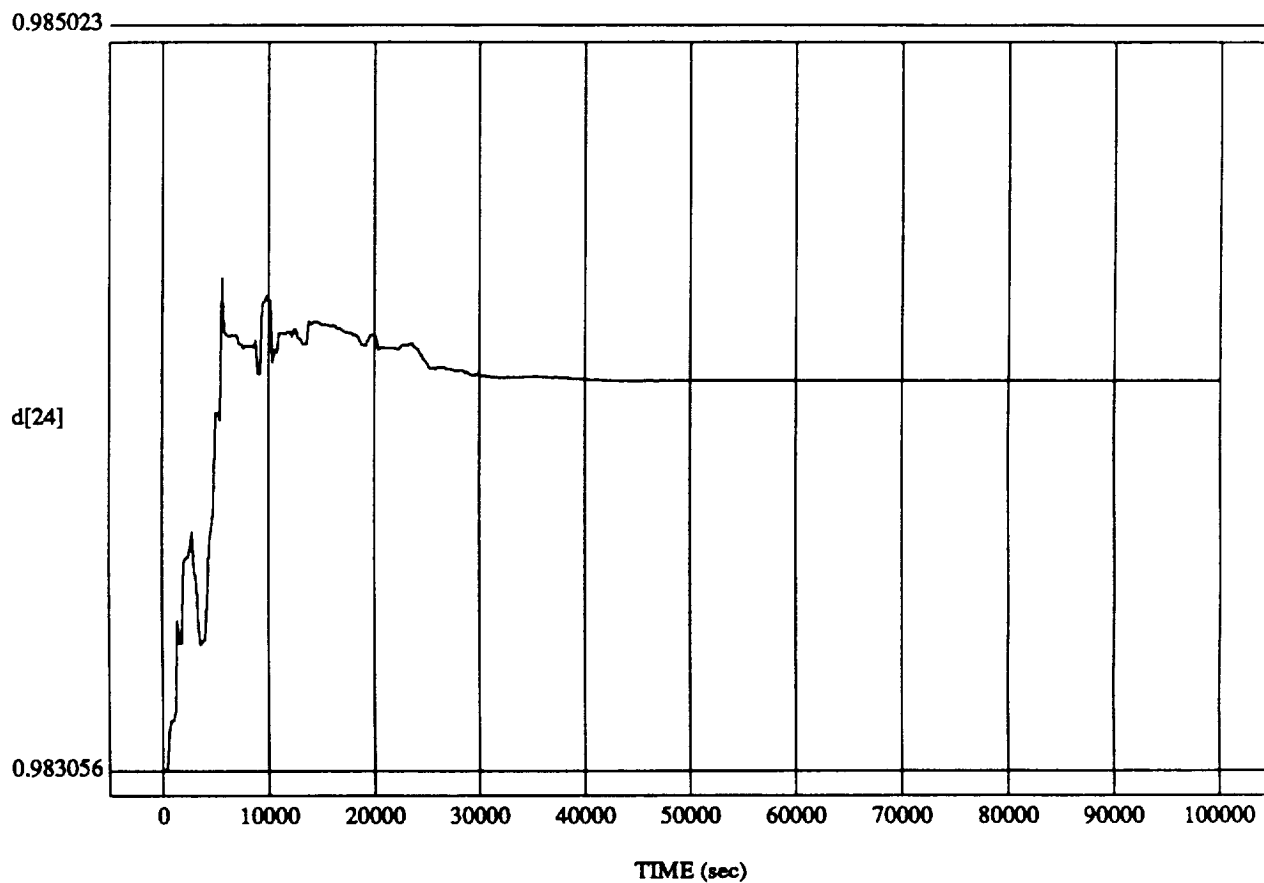


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

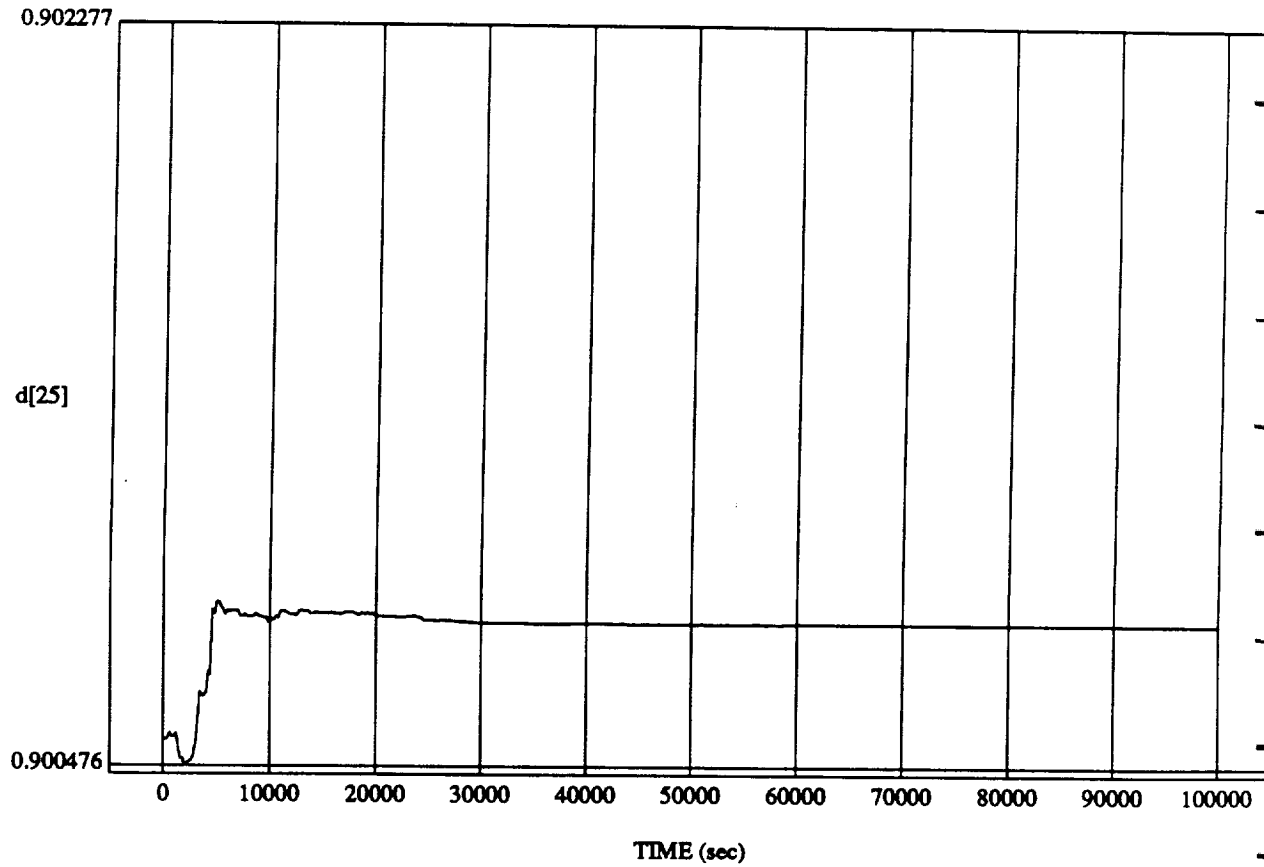
**d[24] vs TIME**  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

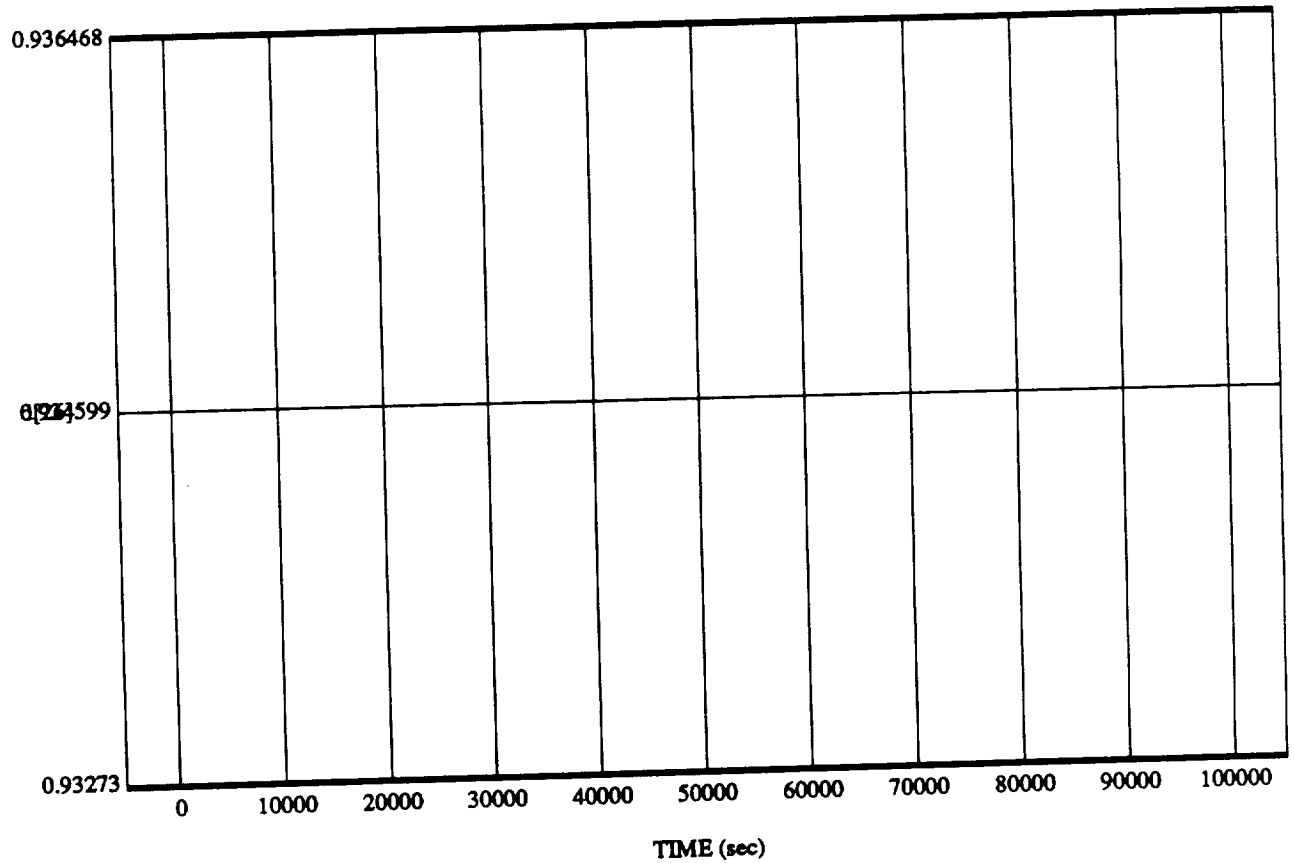
d[25] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

d[26] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

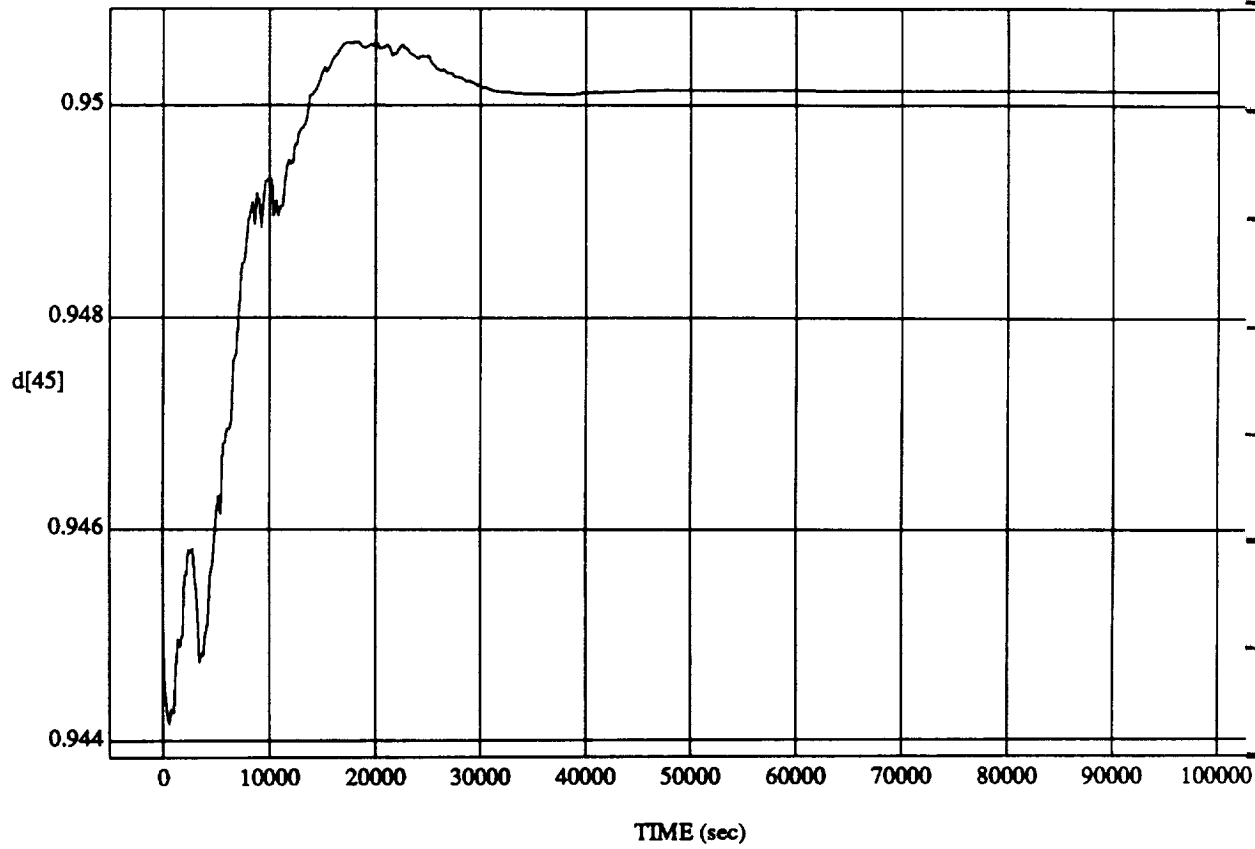


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

d[45] vs TIME

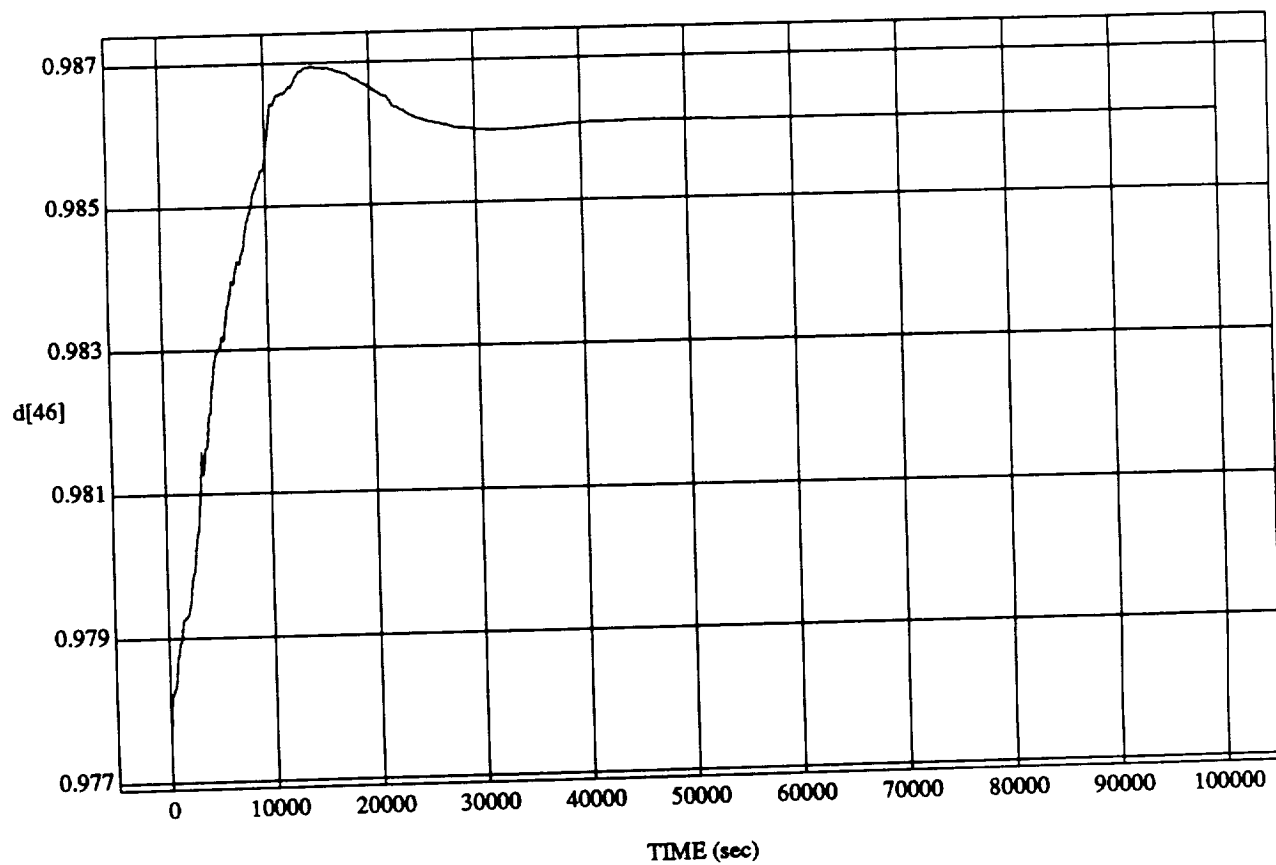
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.lear2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

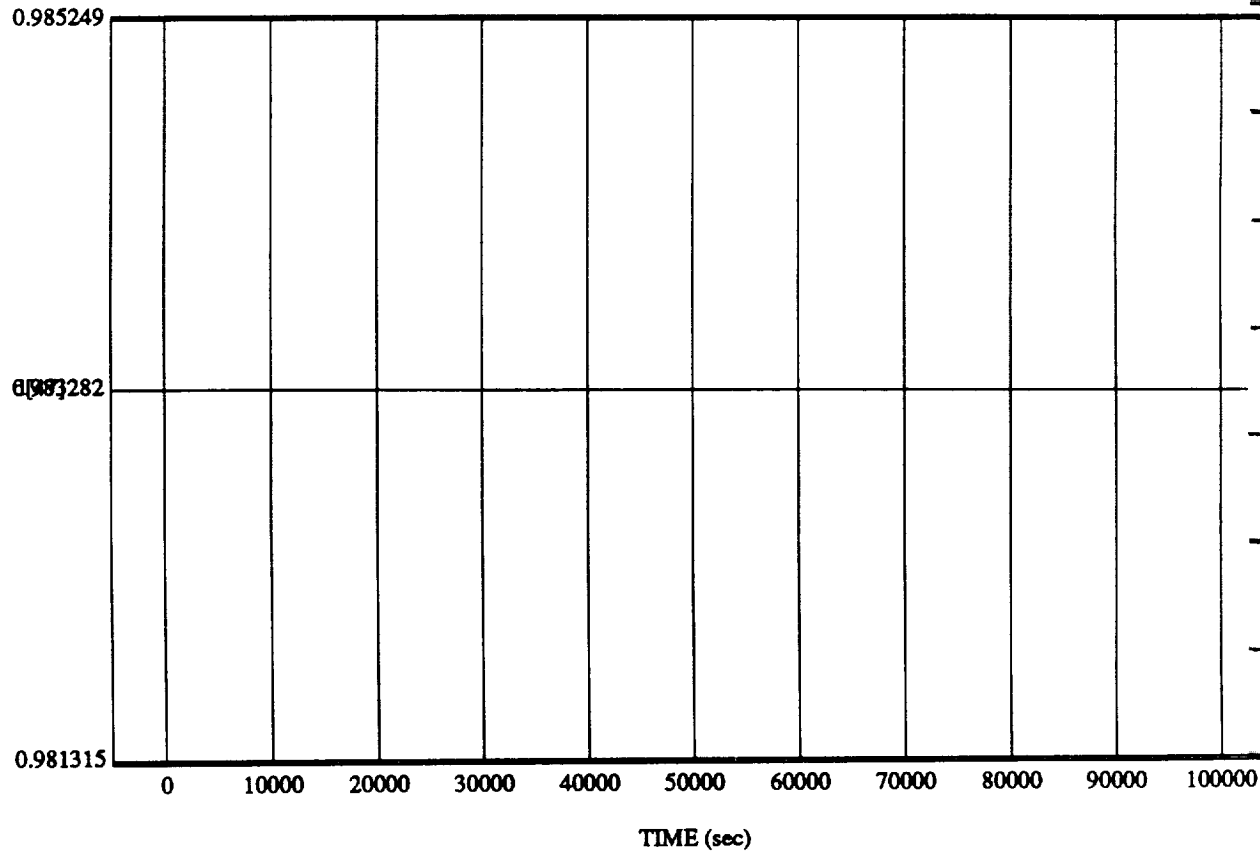
d[46] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

d[47] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

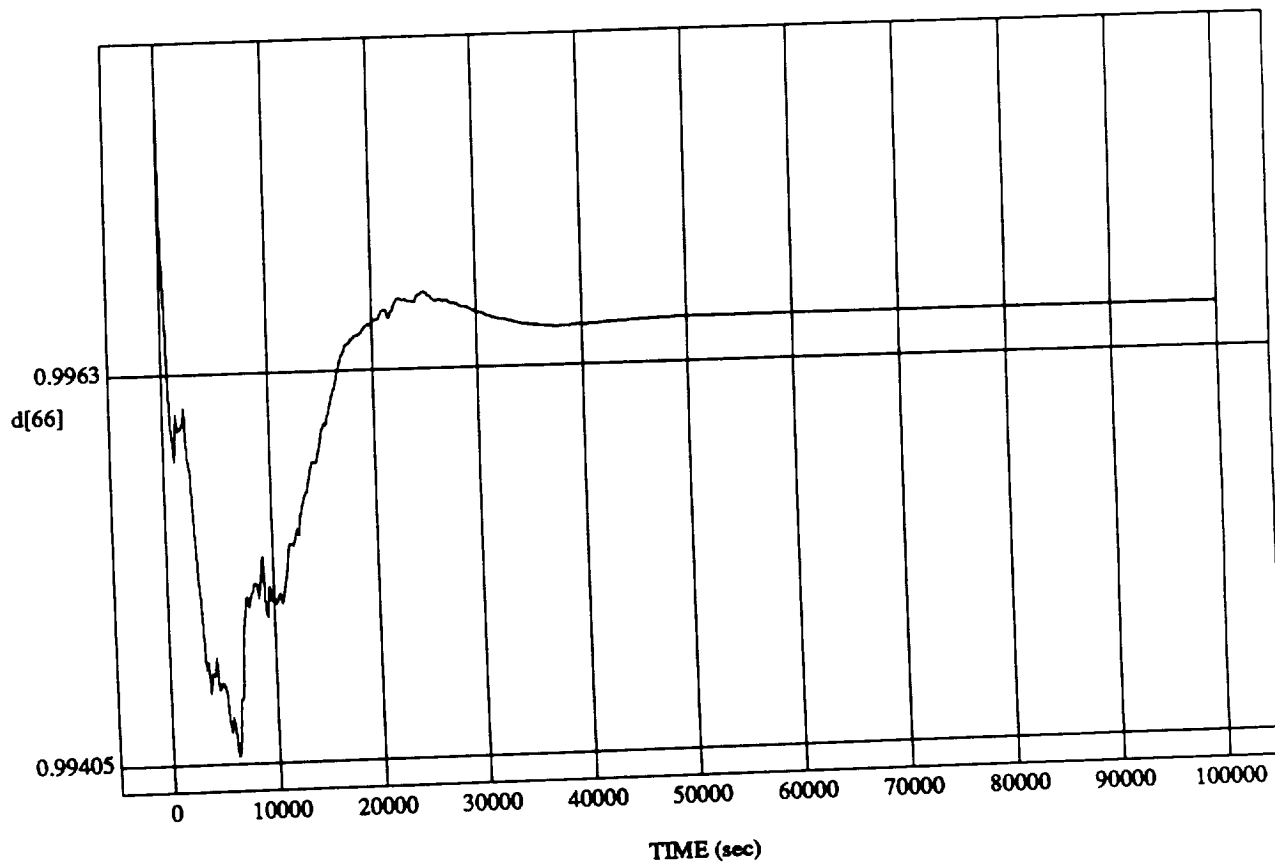


MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

d[66] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

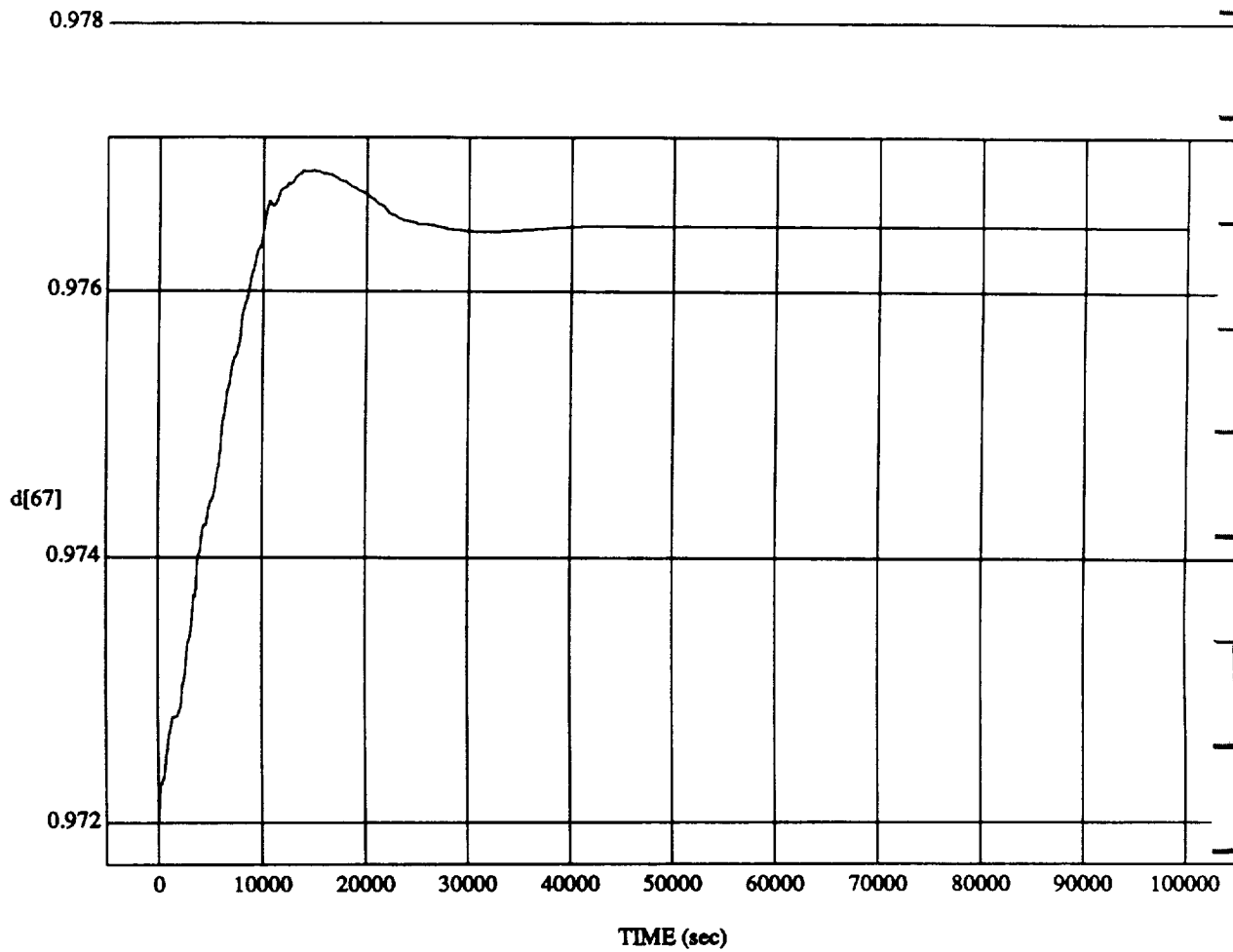
0.99855



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

d[67] vs TIME

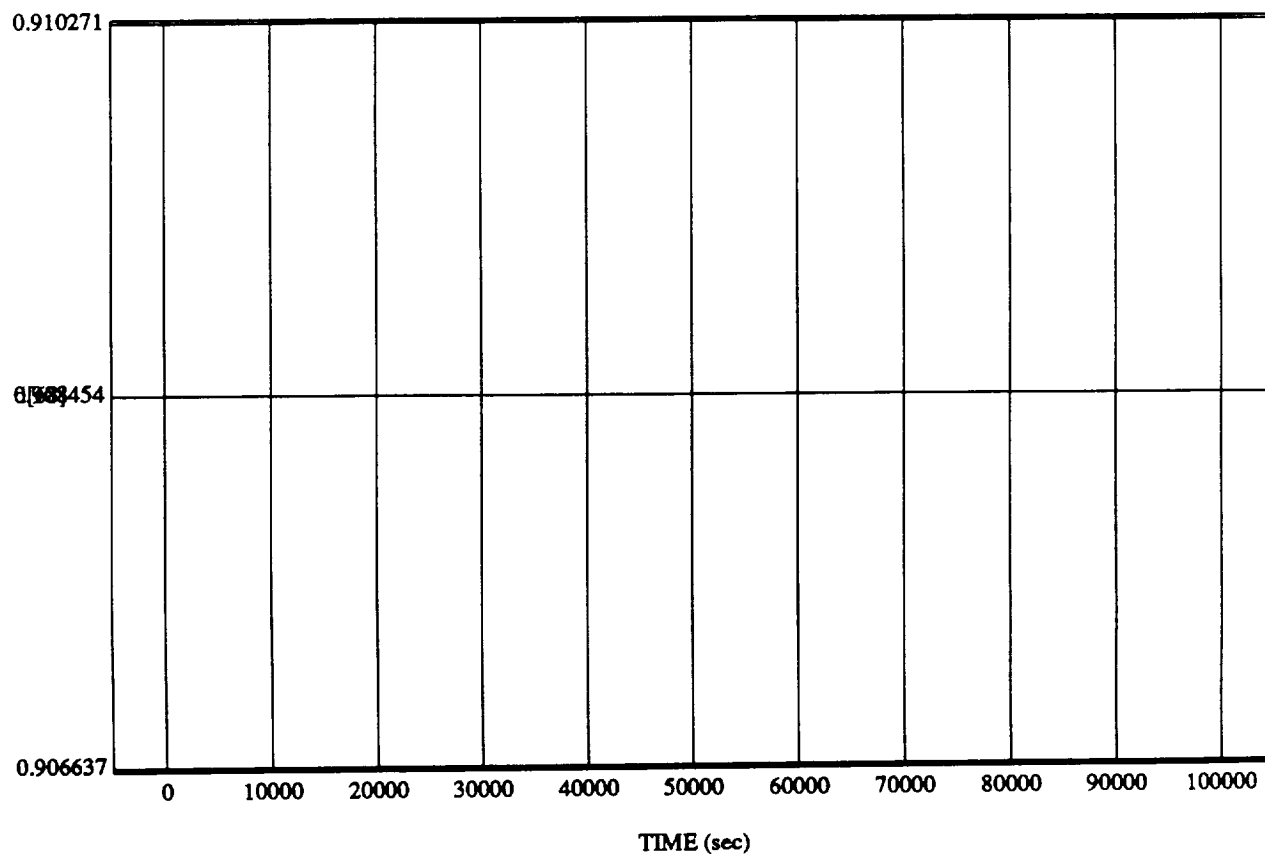
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz



**d[68] vs TIME**  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.005 Hz

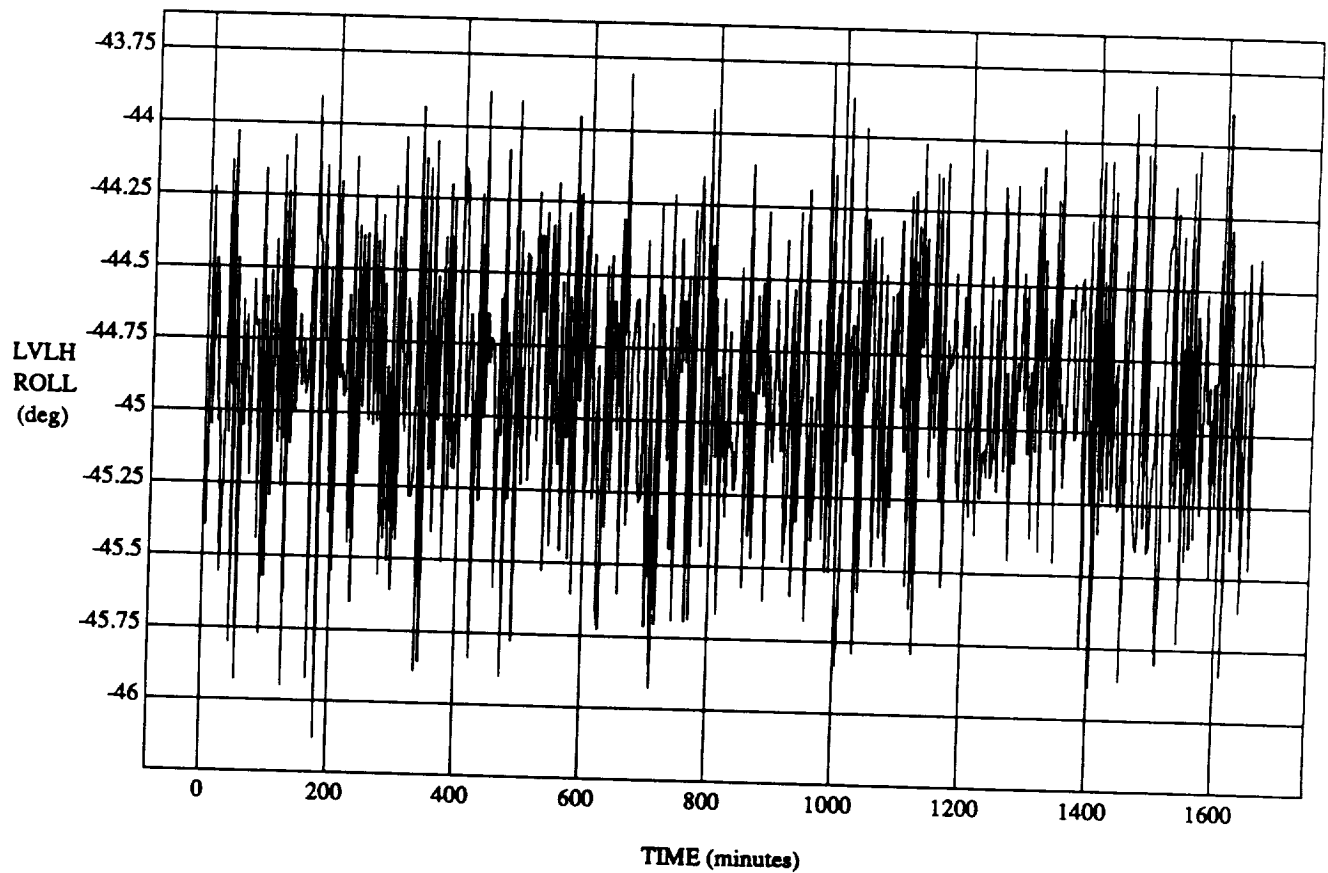


SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

# LVLH EULER PYR ROLL vs TIME

RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

XVI  
same as XV  
but different  
IC

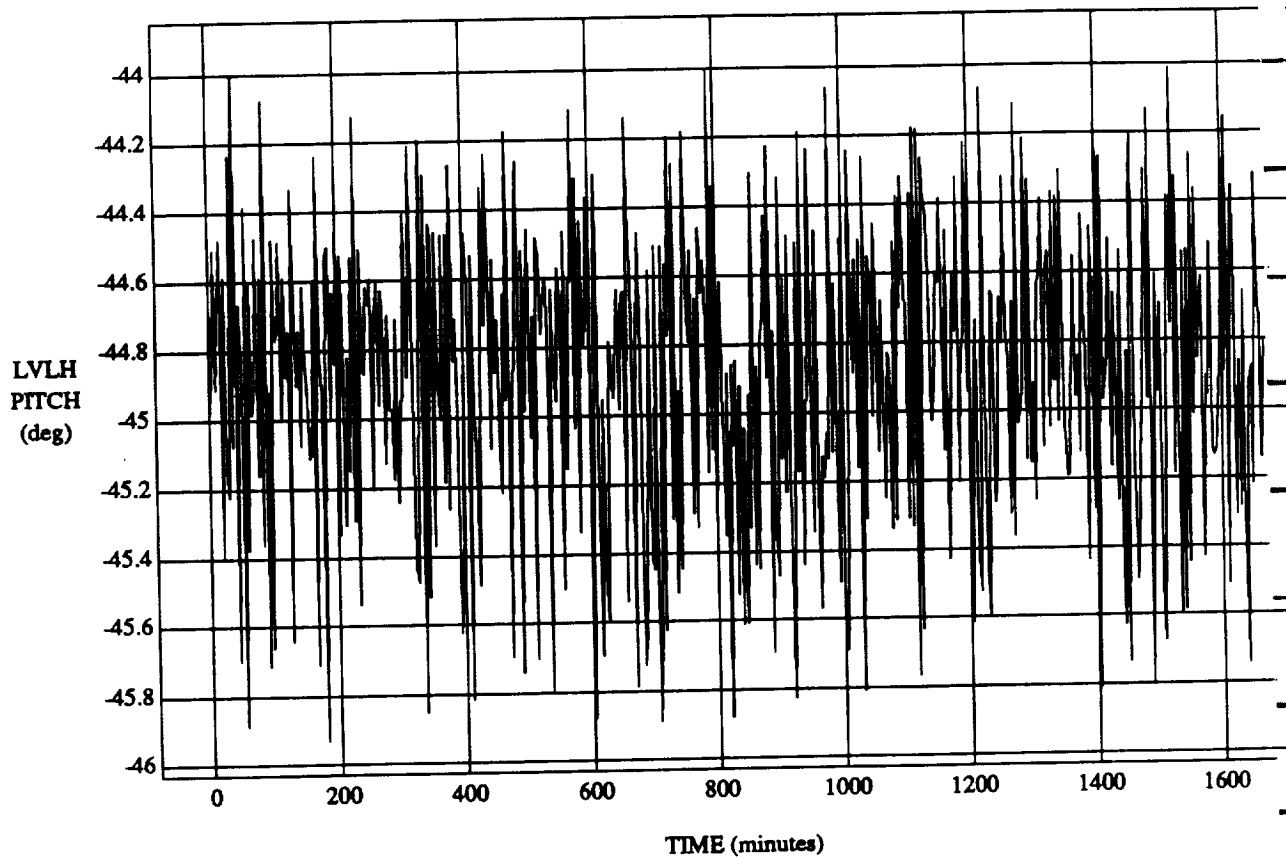


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

# LVLH EULER PYR PITCH vs TIME

RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

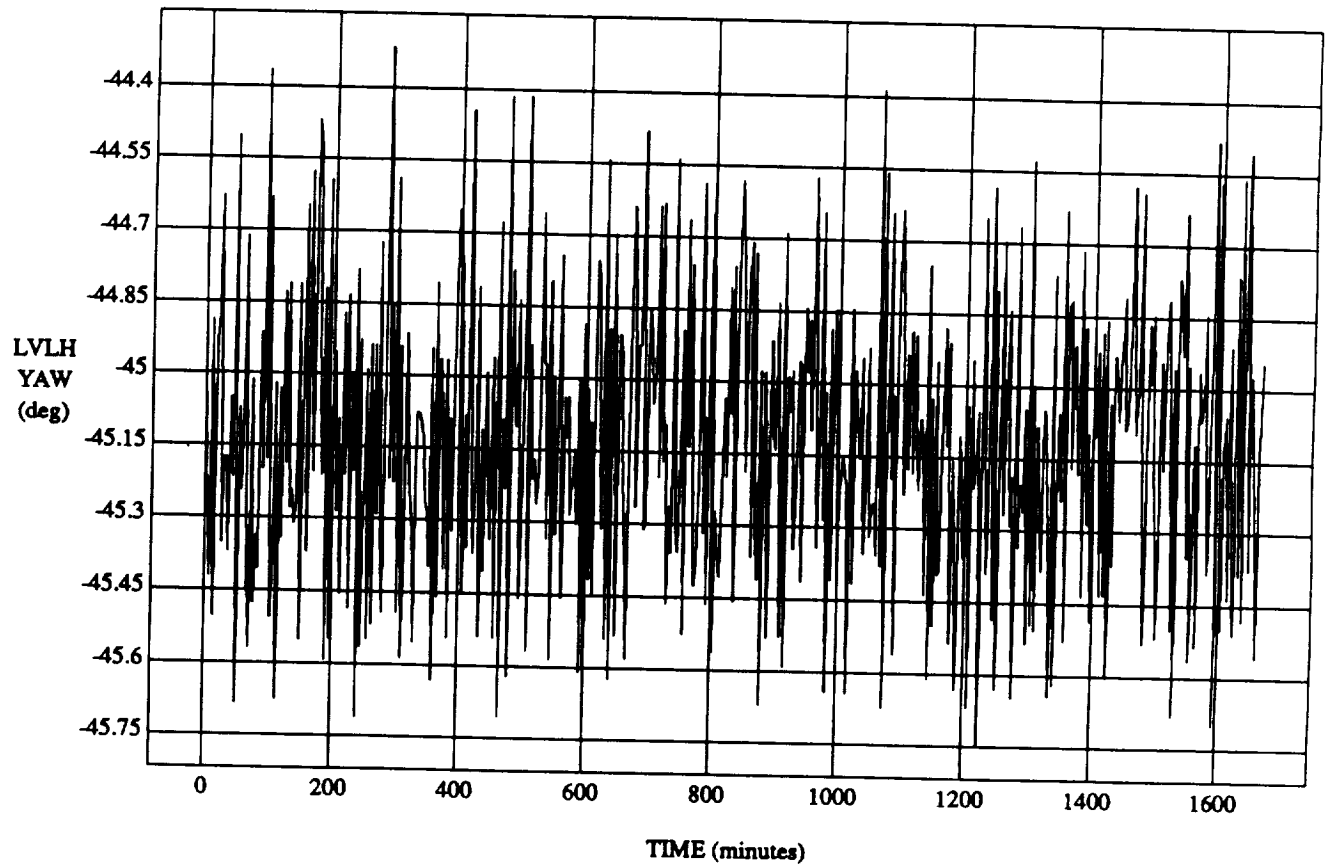


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

# LVLH EULER PYR YAW vs TIME

RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

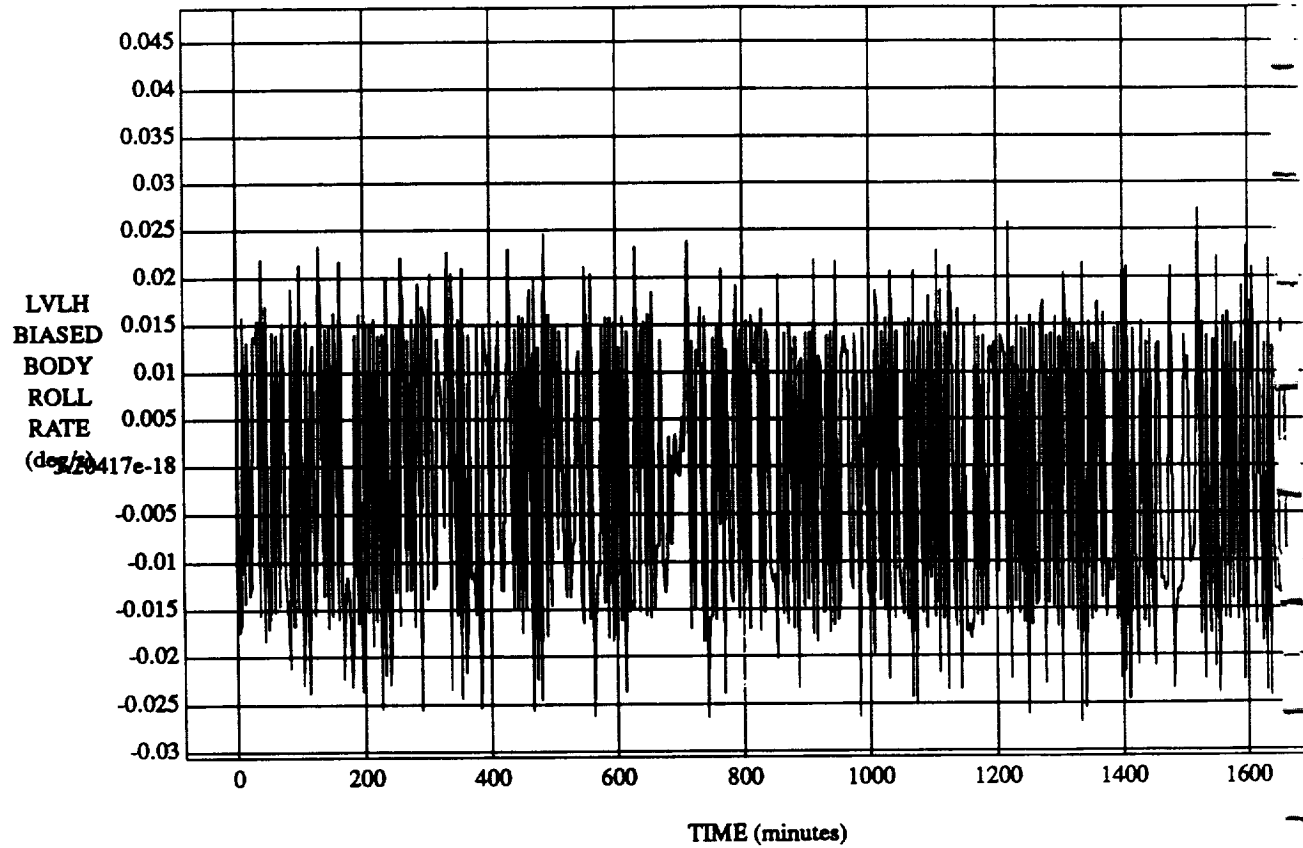


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

### LVLH BIASED BODY ROLL RATE vs TIME

RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

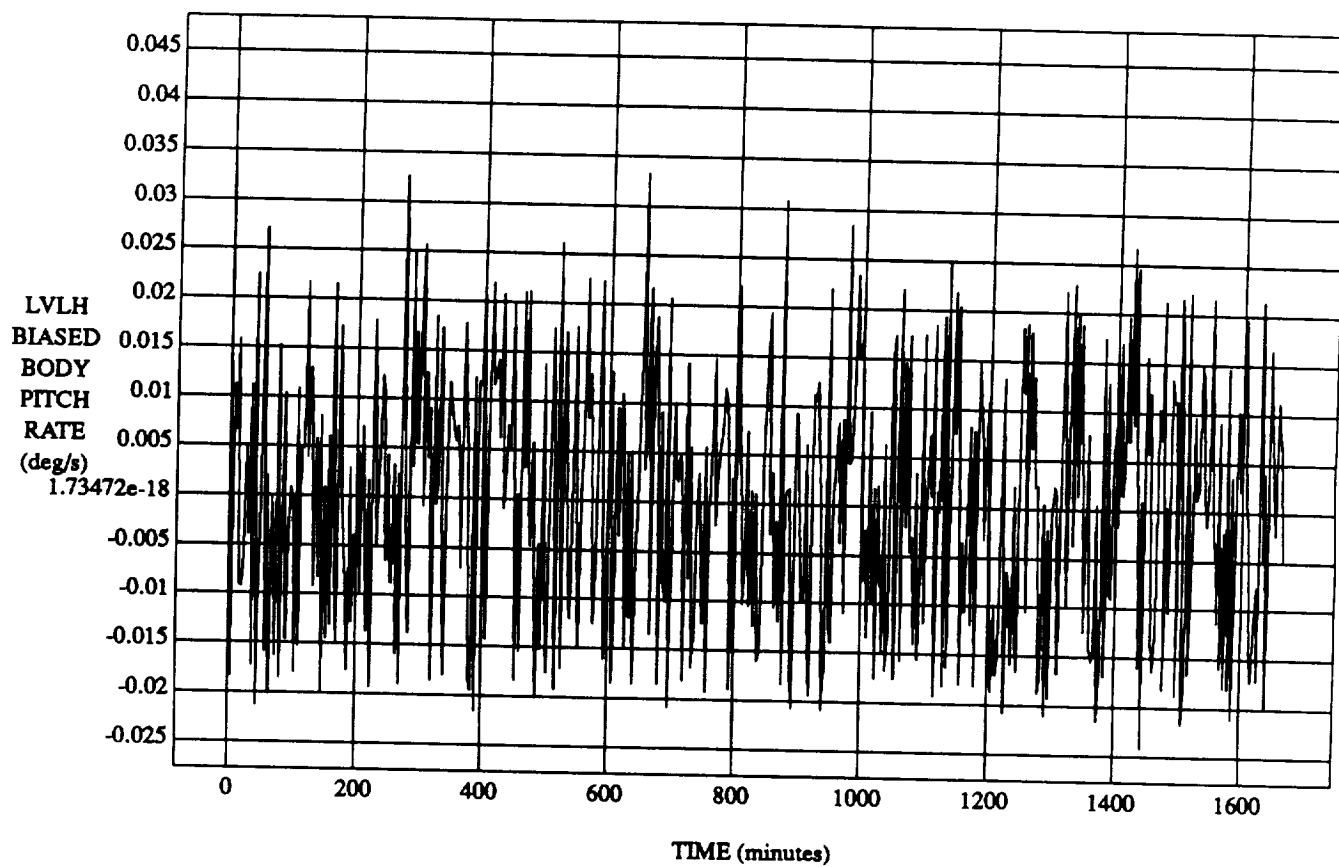


VEHICLE: ORB\_FUZZ\_BATCH.state  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

### LVLH BIASED BODY PITCH RATE vs TIME

RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

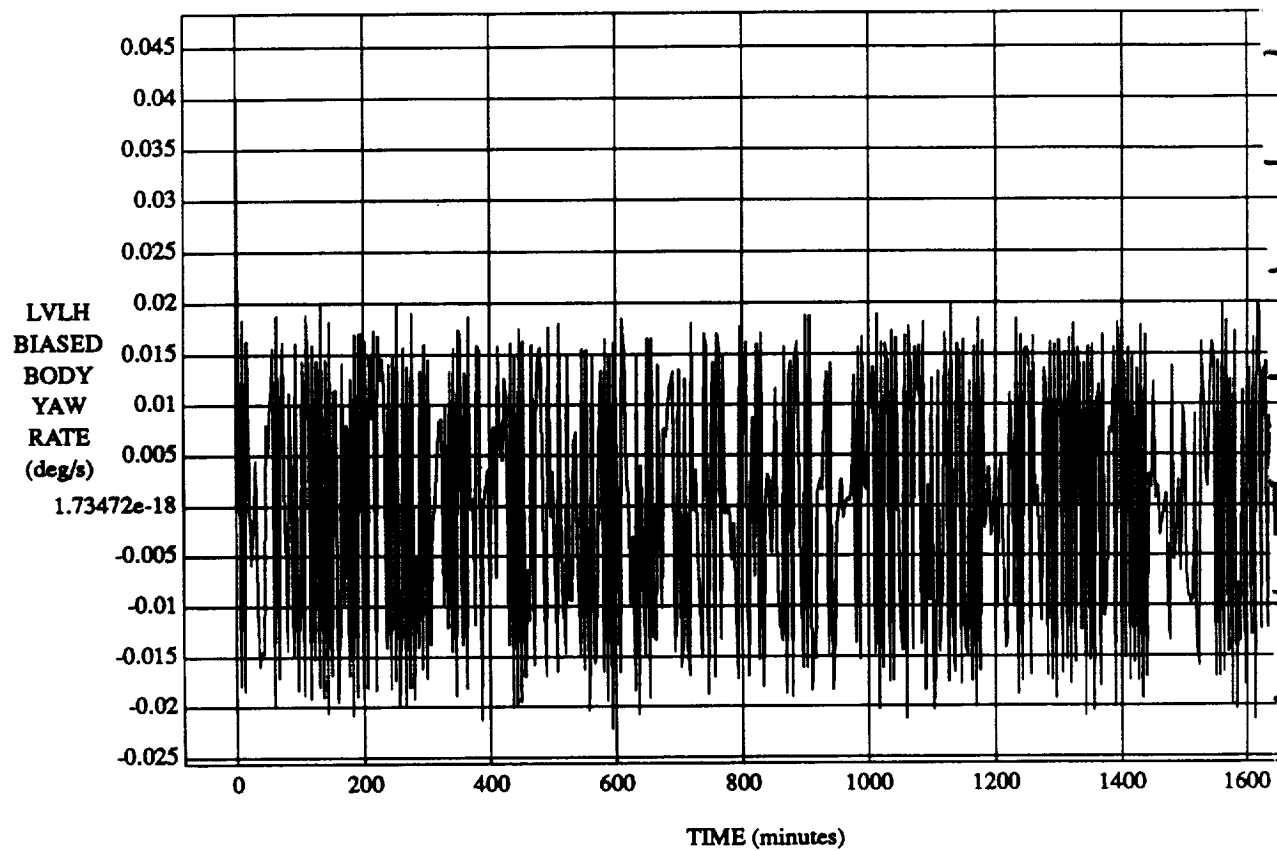


VEHICLE: ORB\_FUZZ\_BATCH.state

DATA SAMPLING FREQUENCY: 0.005 Hz

### LVLH BIASED BODY YAW RATE vs TIME

RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



VEHICLE: ORB\_FUZZ\_BATCH.state

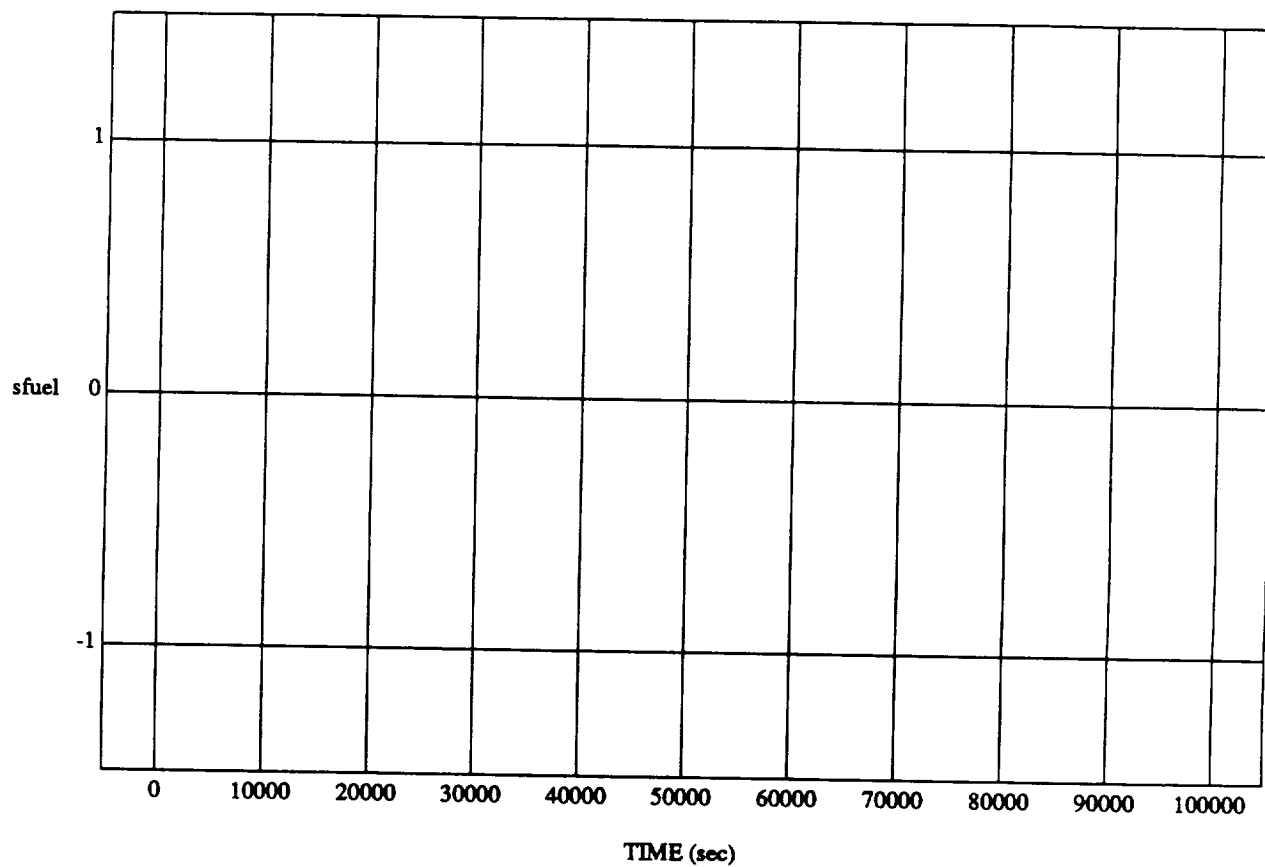
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

### sfuel vs TIME

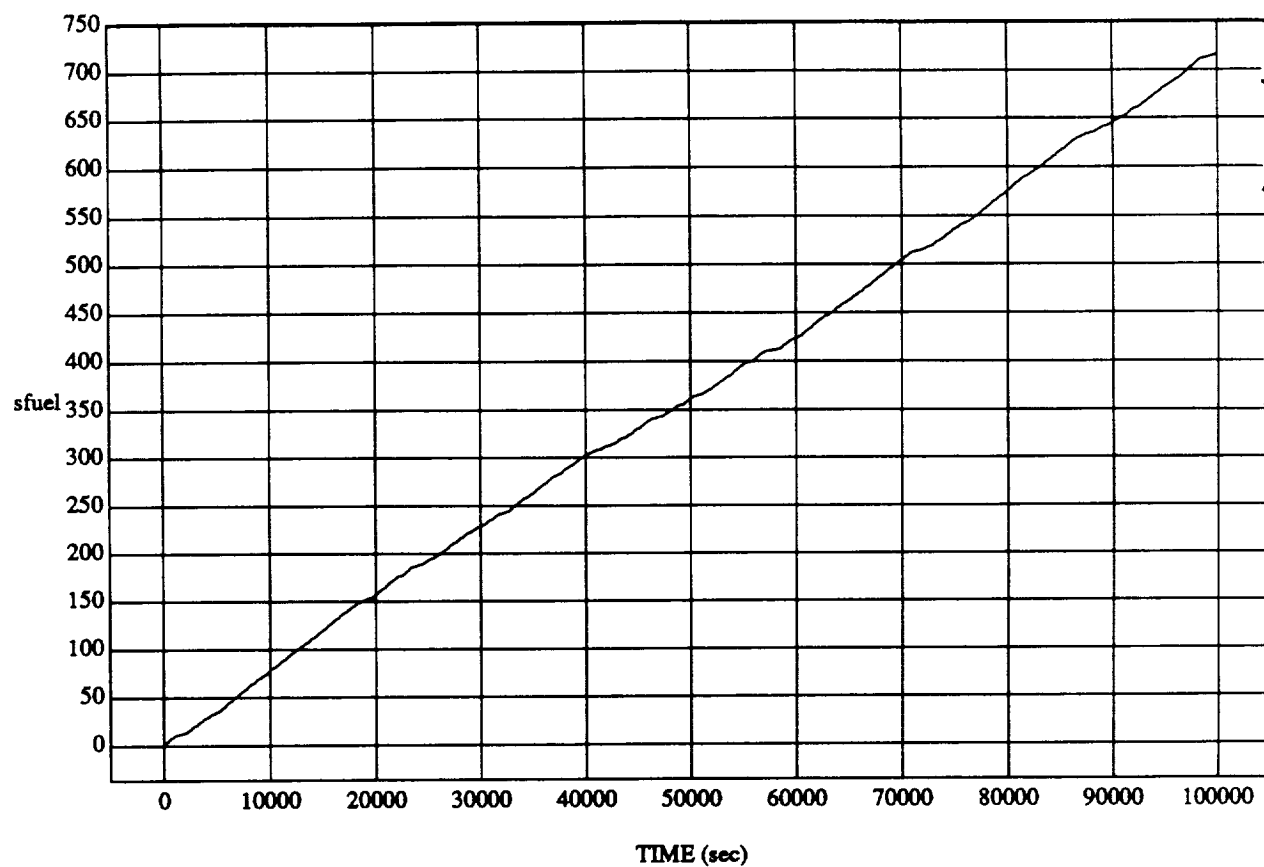
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.primary  
DATA SAMPLING FREQUENCY: 0.005 Hz

### sfuel vs TIME

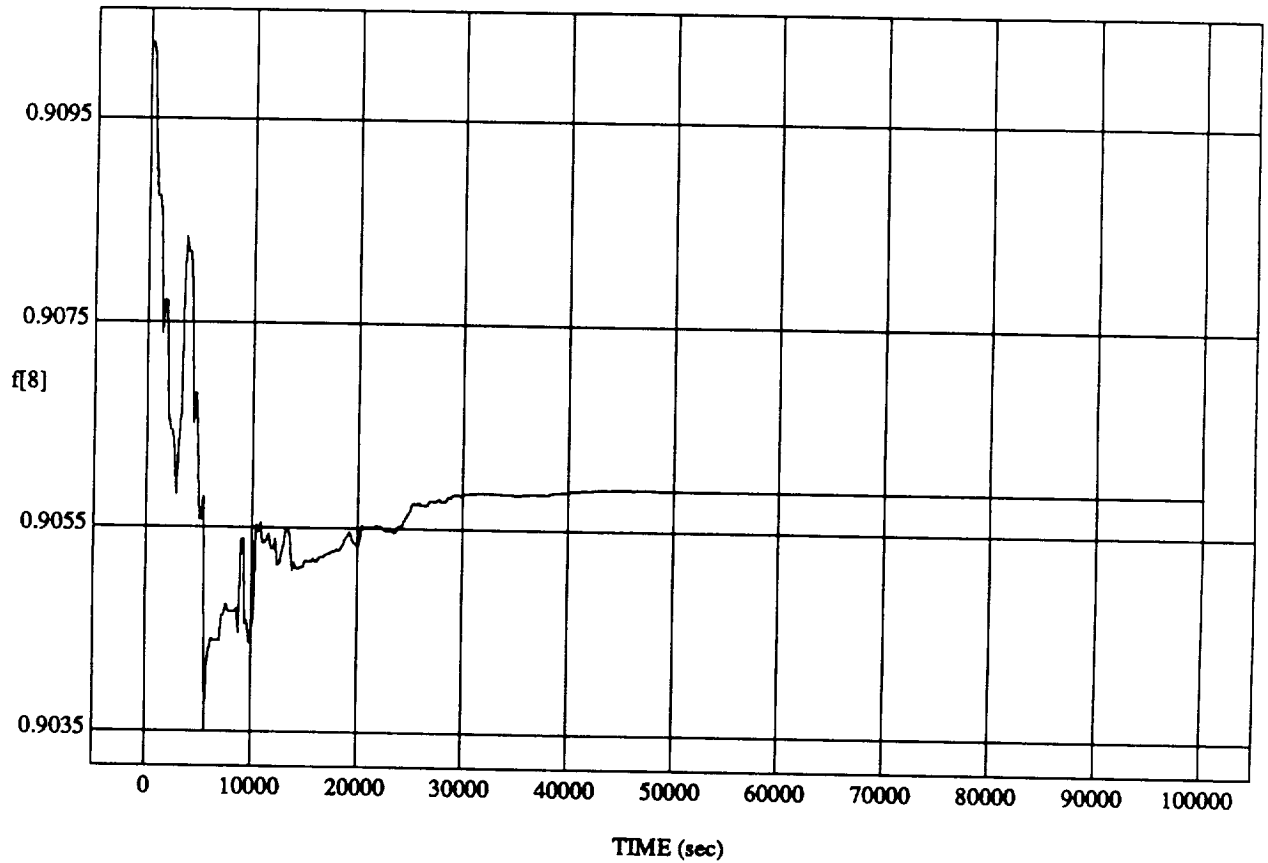
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.vernier  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

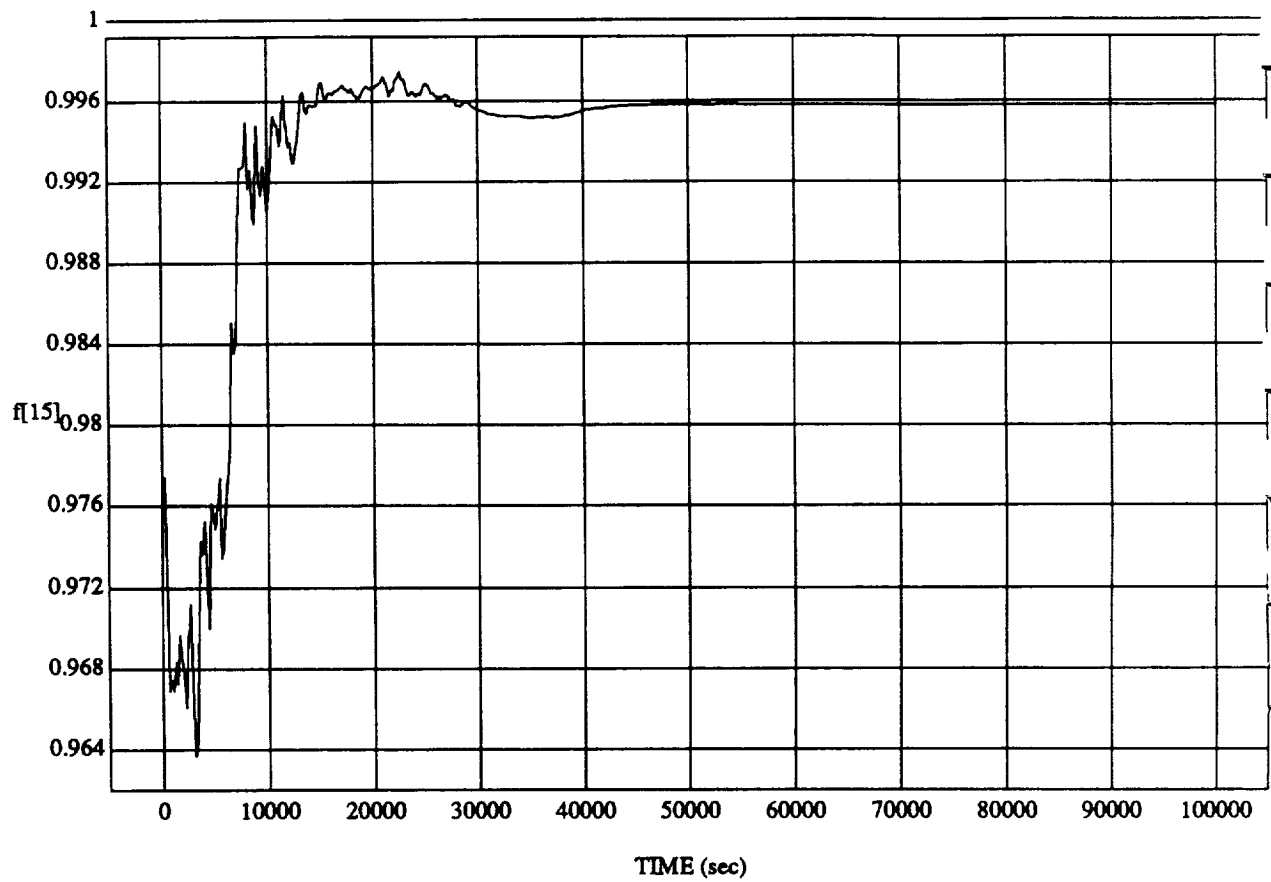
$f[8]$  vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

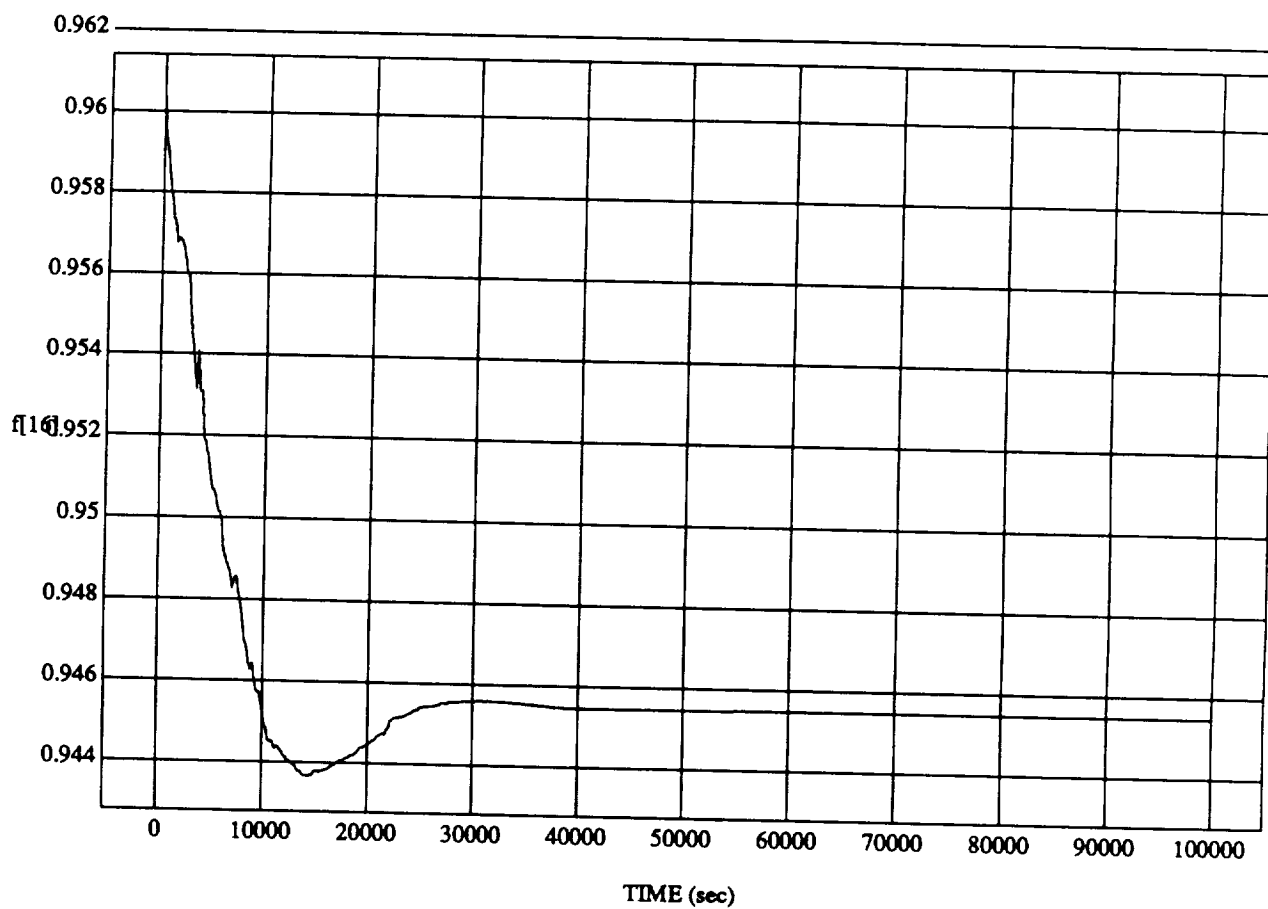
$f[15]$  vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

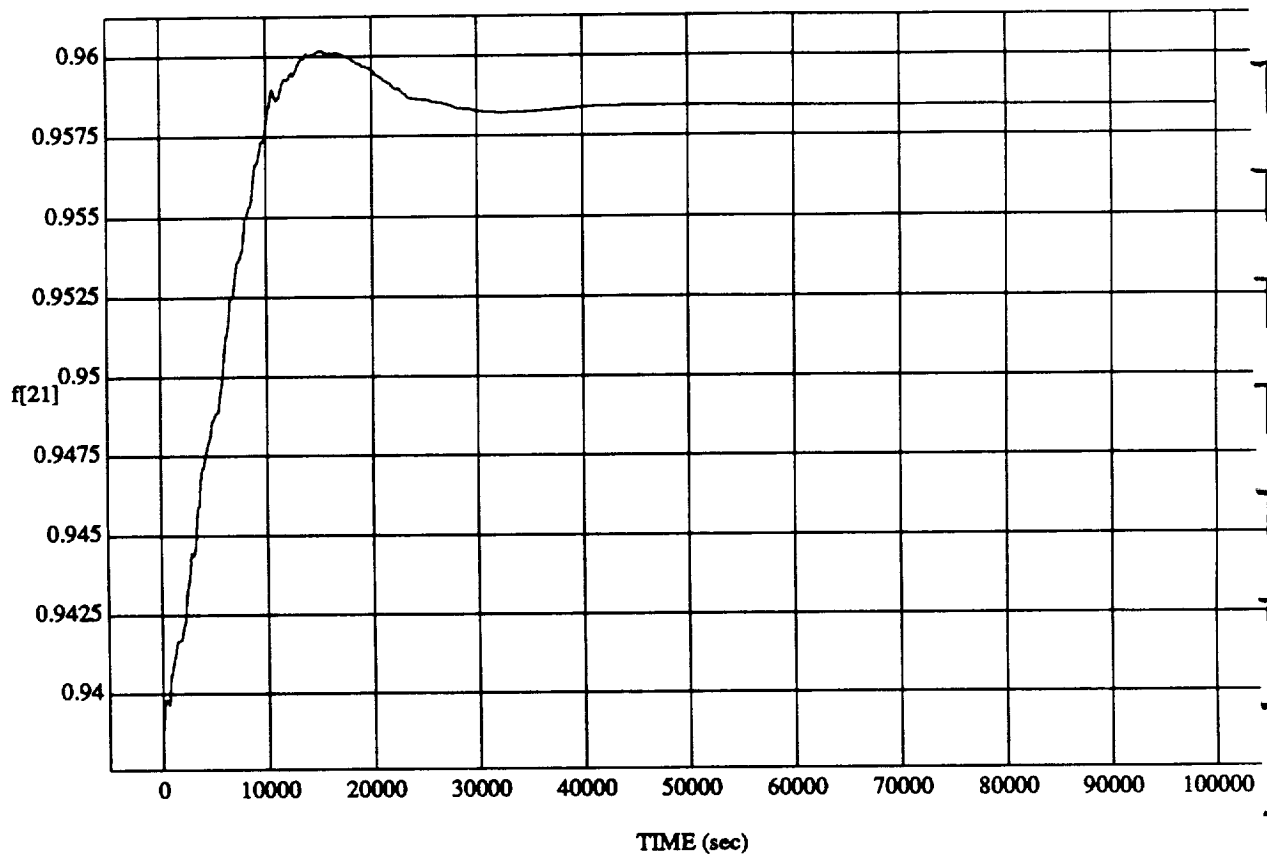
**f[16] vs TIME**  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.1eam2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

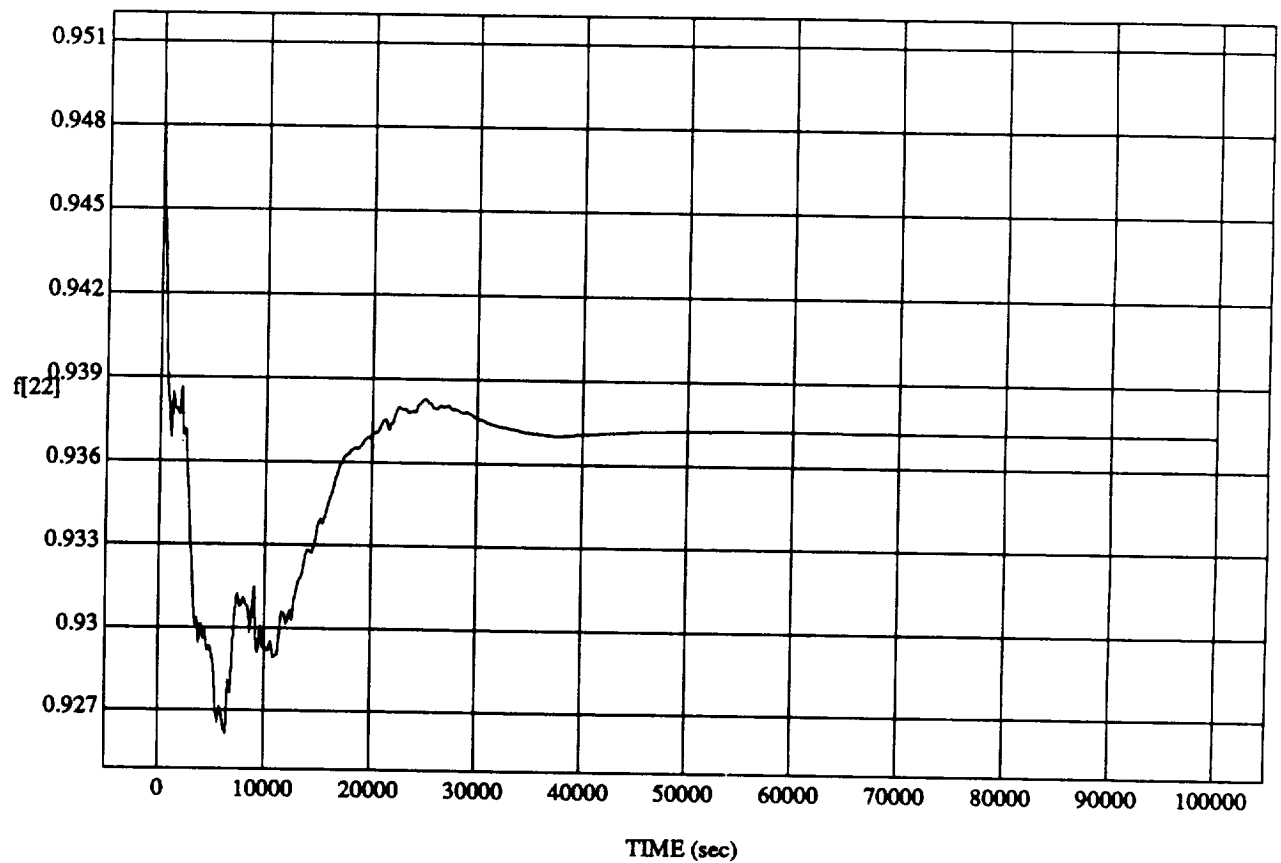
f[21] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

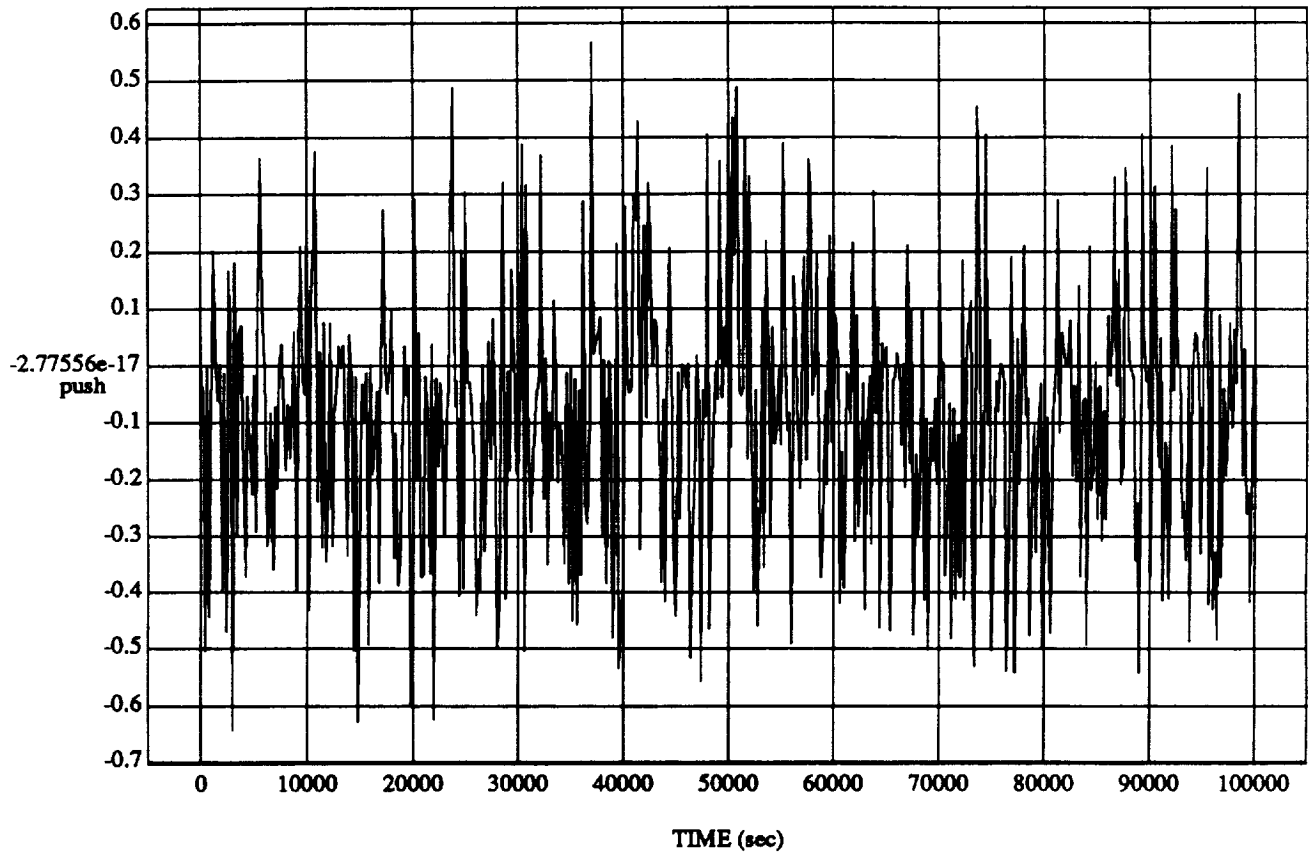
$f[22]$  vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

push vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

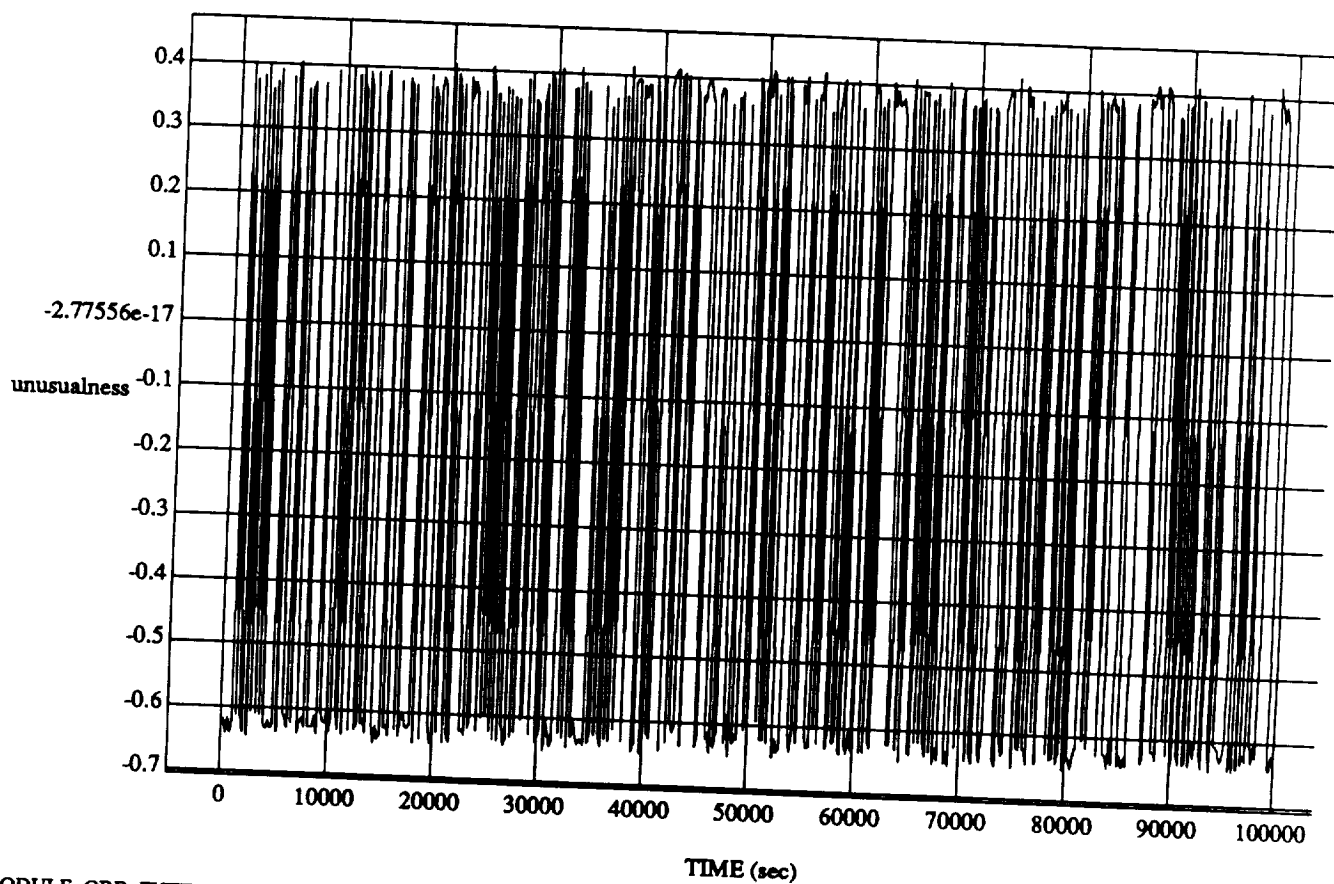


MODULE: ORB\_FUZZ\_BATCH.learm2  
DATA SAMPLING FREQUENCY: 0.005 Hz



SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

unusualness vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

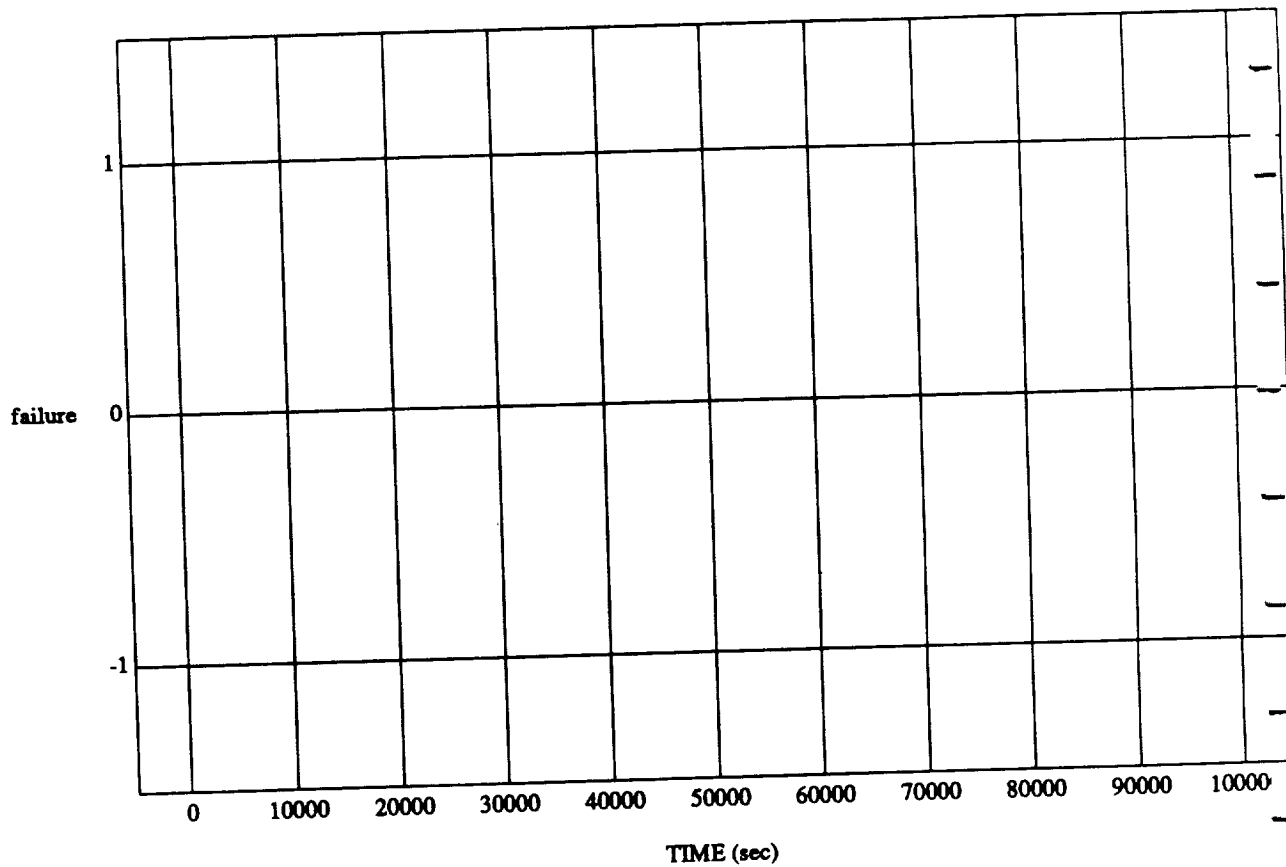


MODULE: ORB\_FUZZ\_BATCH.lean2

DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

failure vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

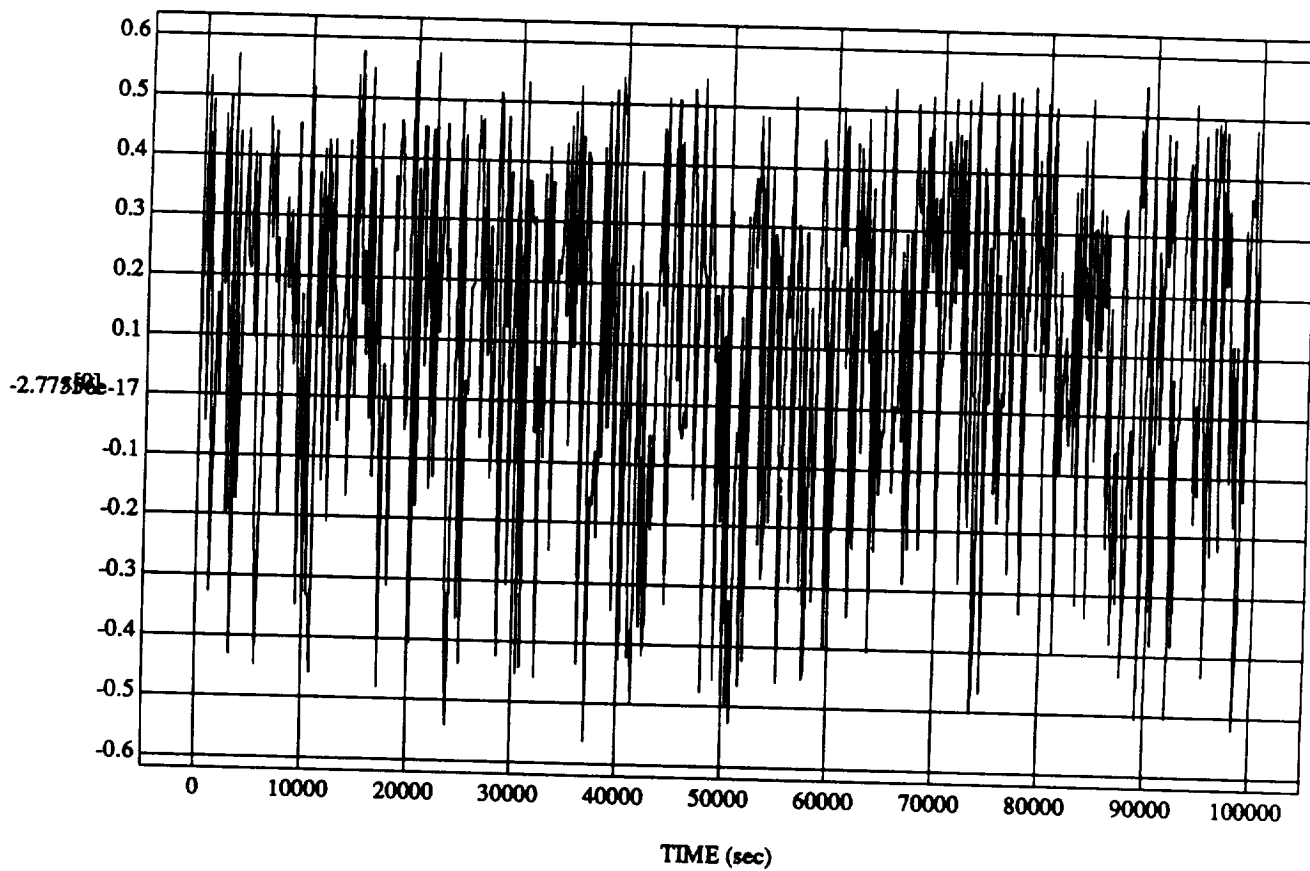


MODULE: ORB\_FUZZ\_BATCH.1cam2  
DATA SAMPLING FREQUENCY: 0.005 Hz

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SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

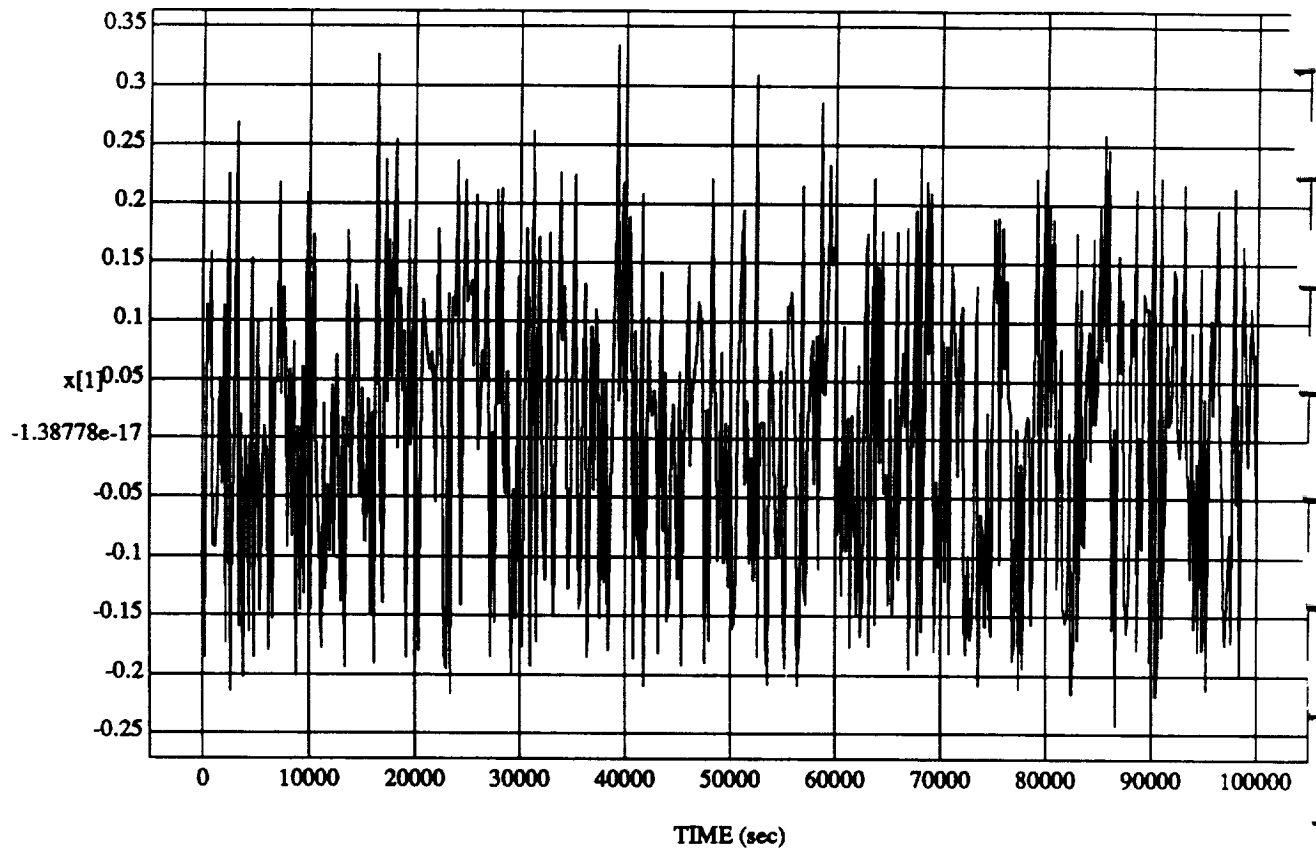
$x[0]$  vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

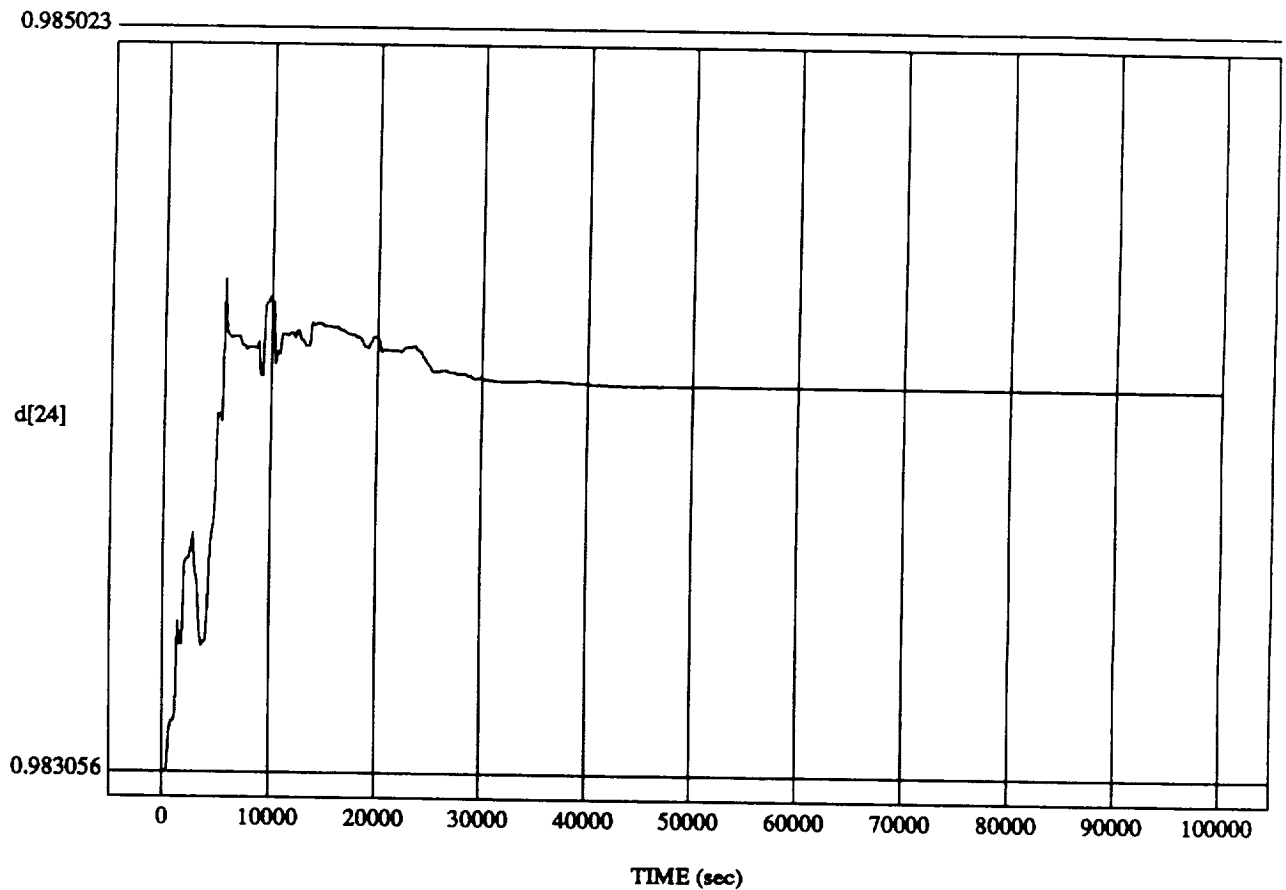
$x[1]$  vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

d[24] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

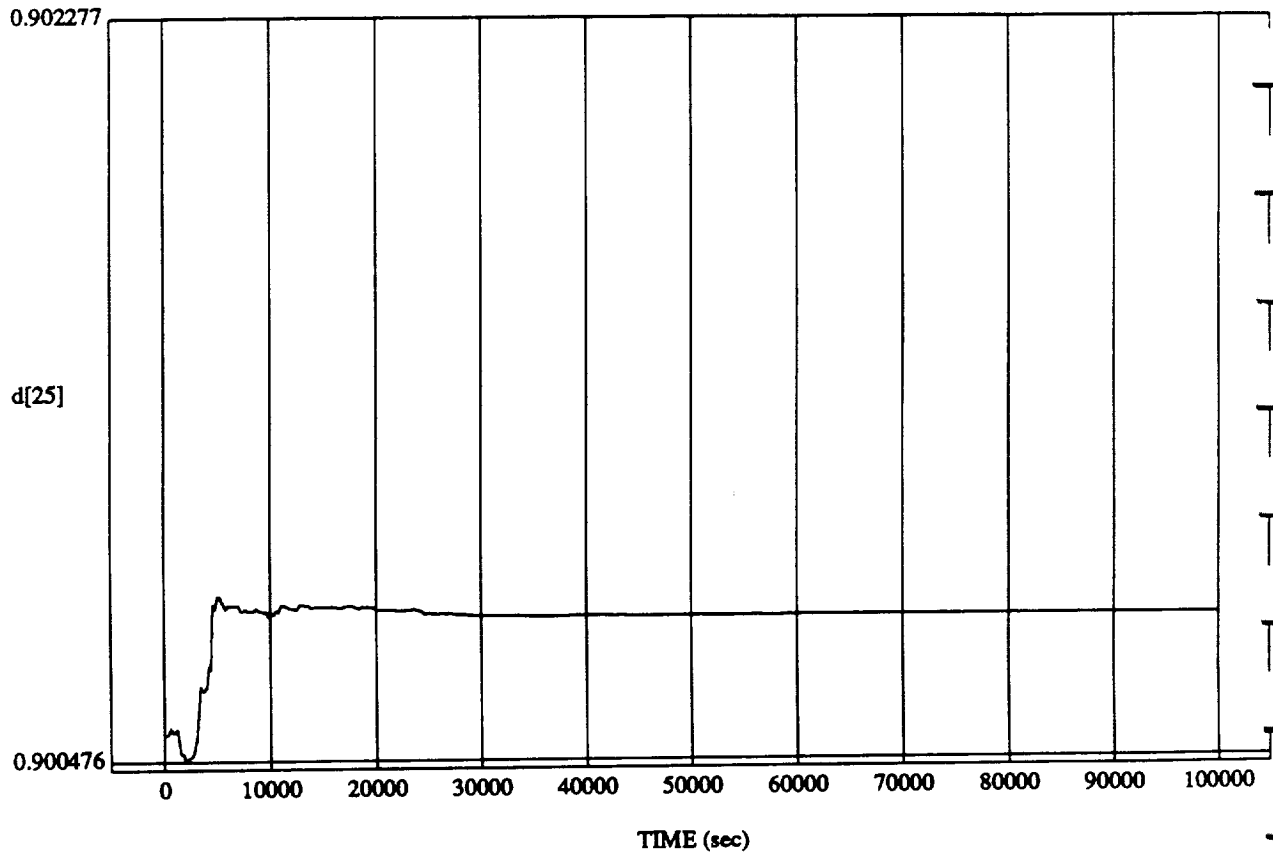


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

d[25] vs TIME

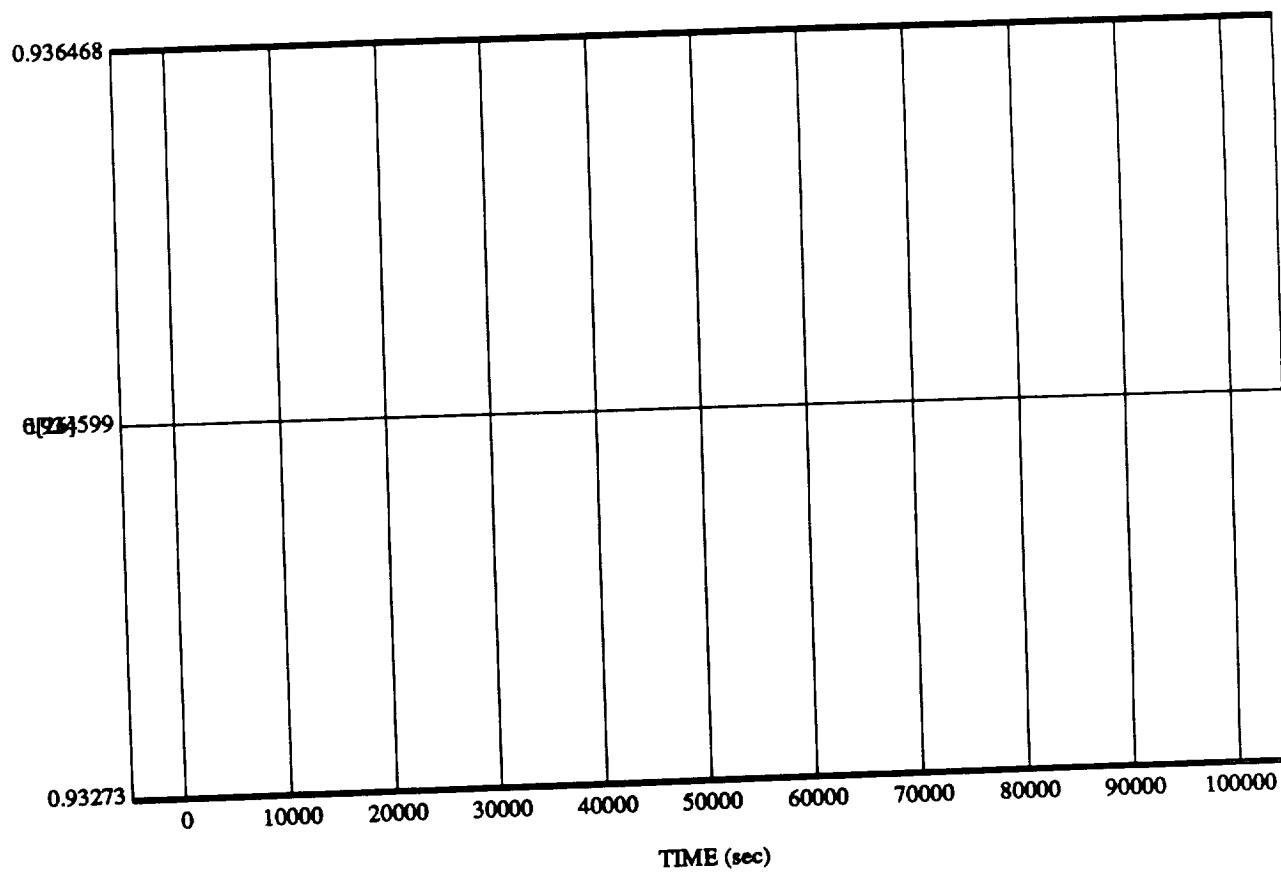
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

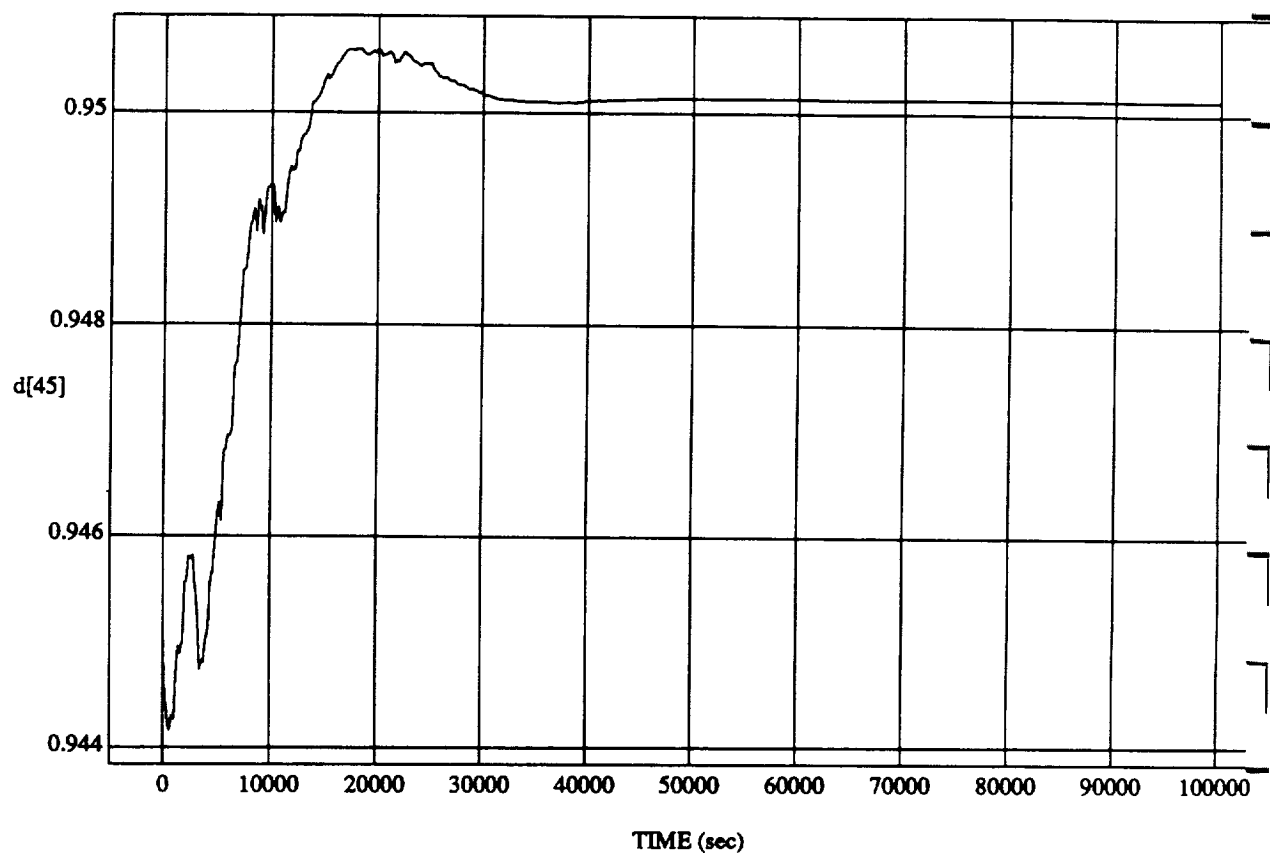
d[26] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

d[45] vs TIME

RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold

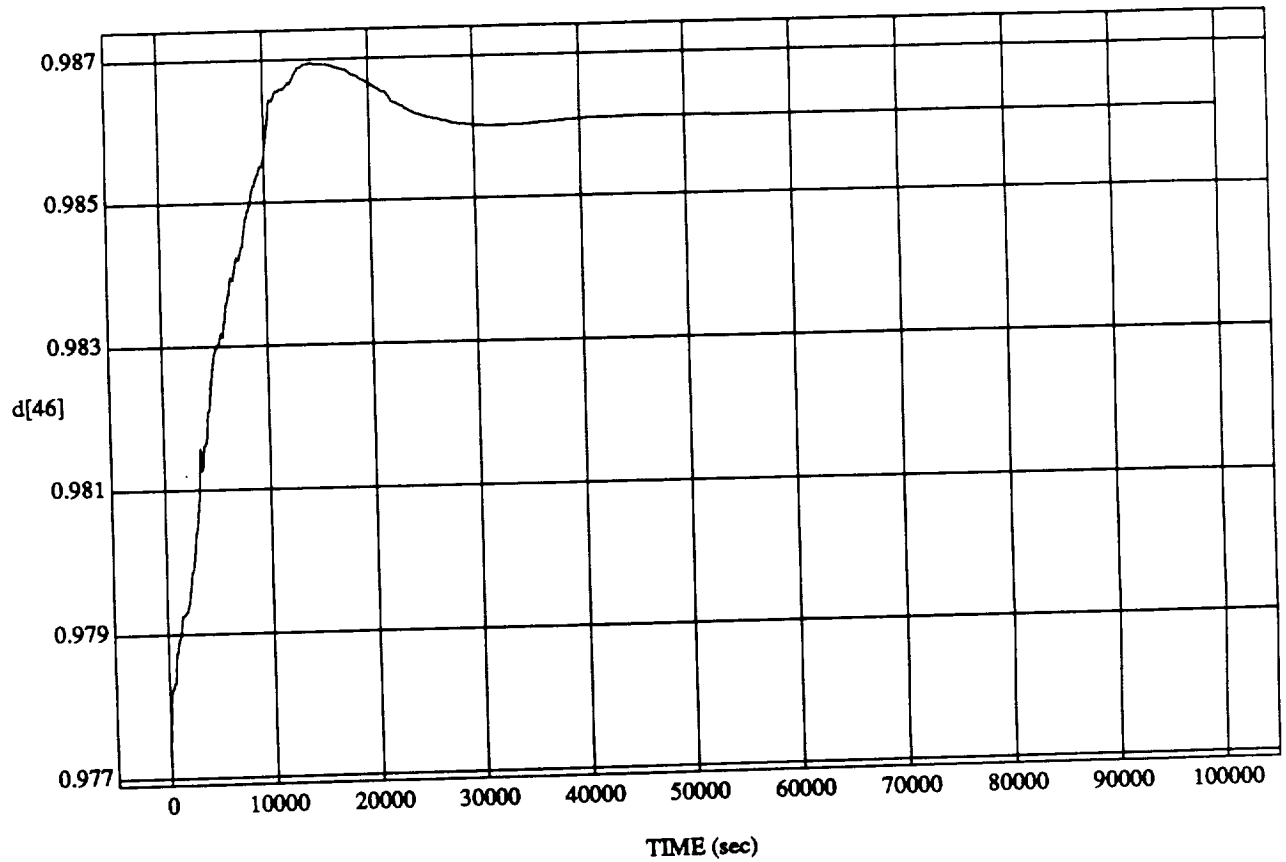


MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz



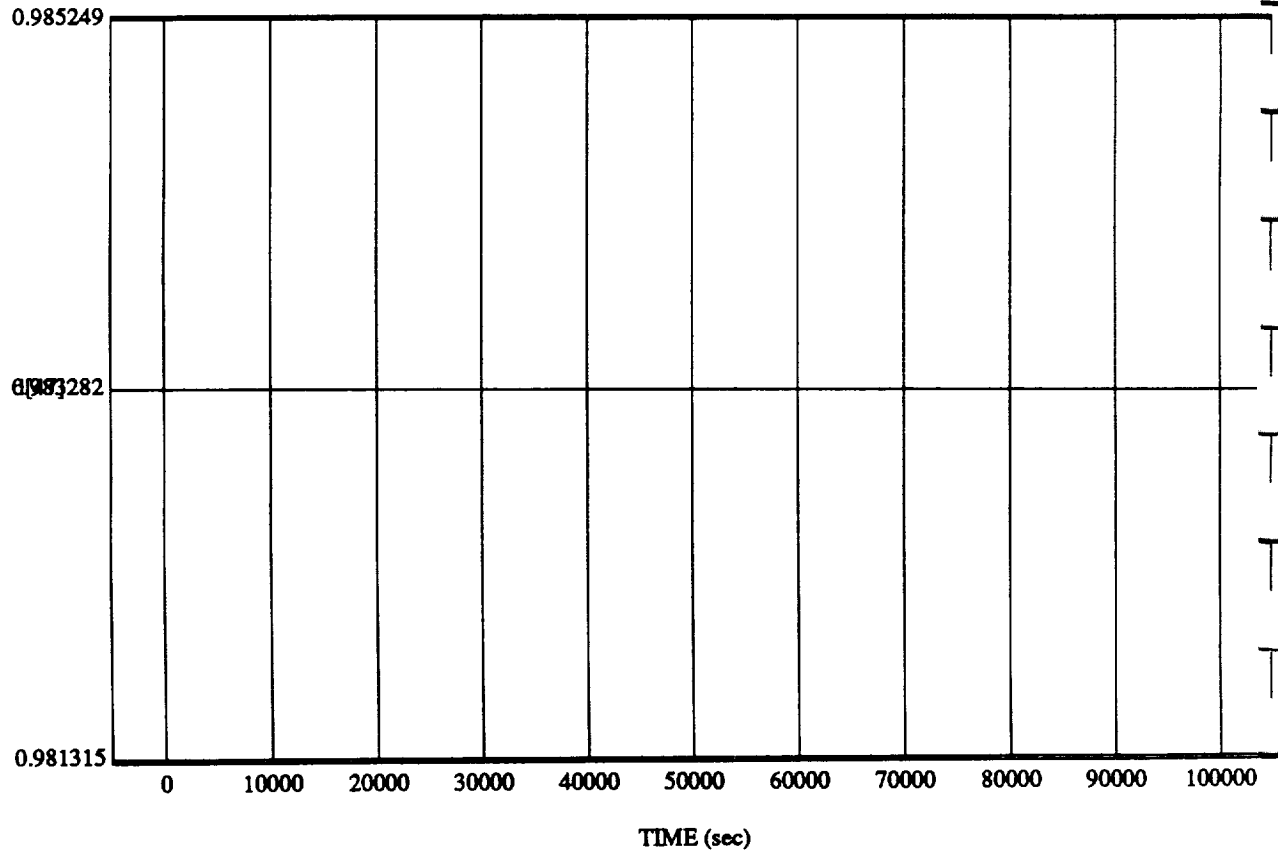
SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

d[46] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

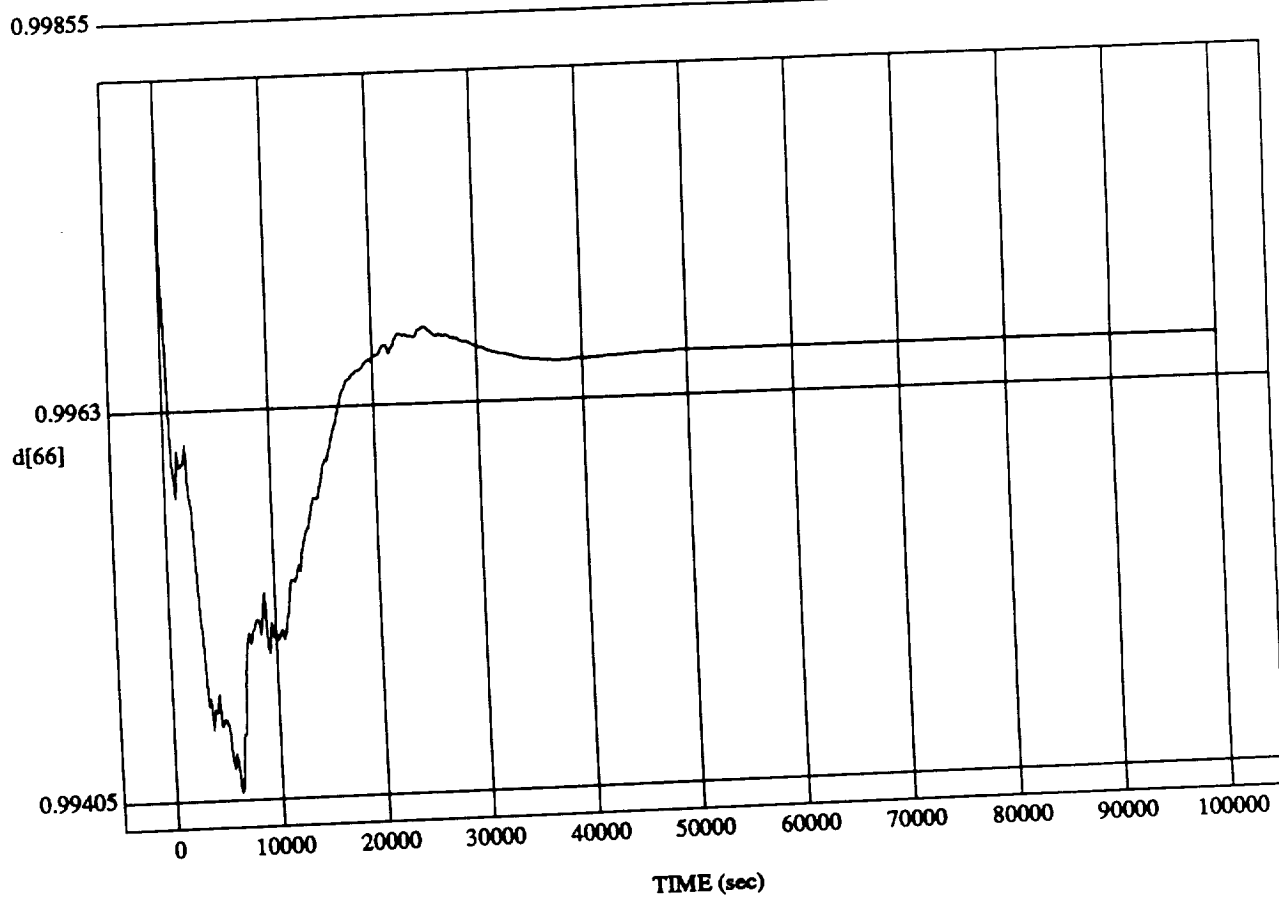
d[47] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

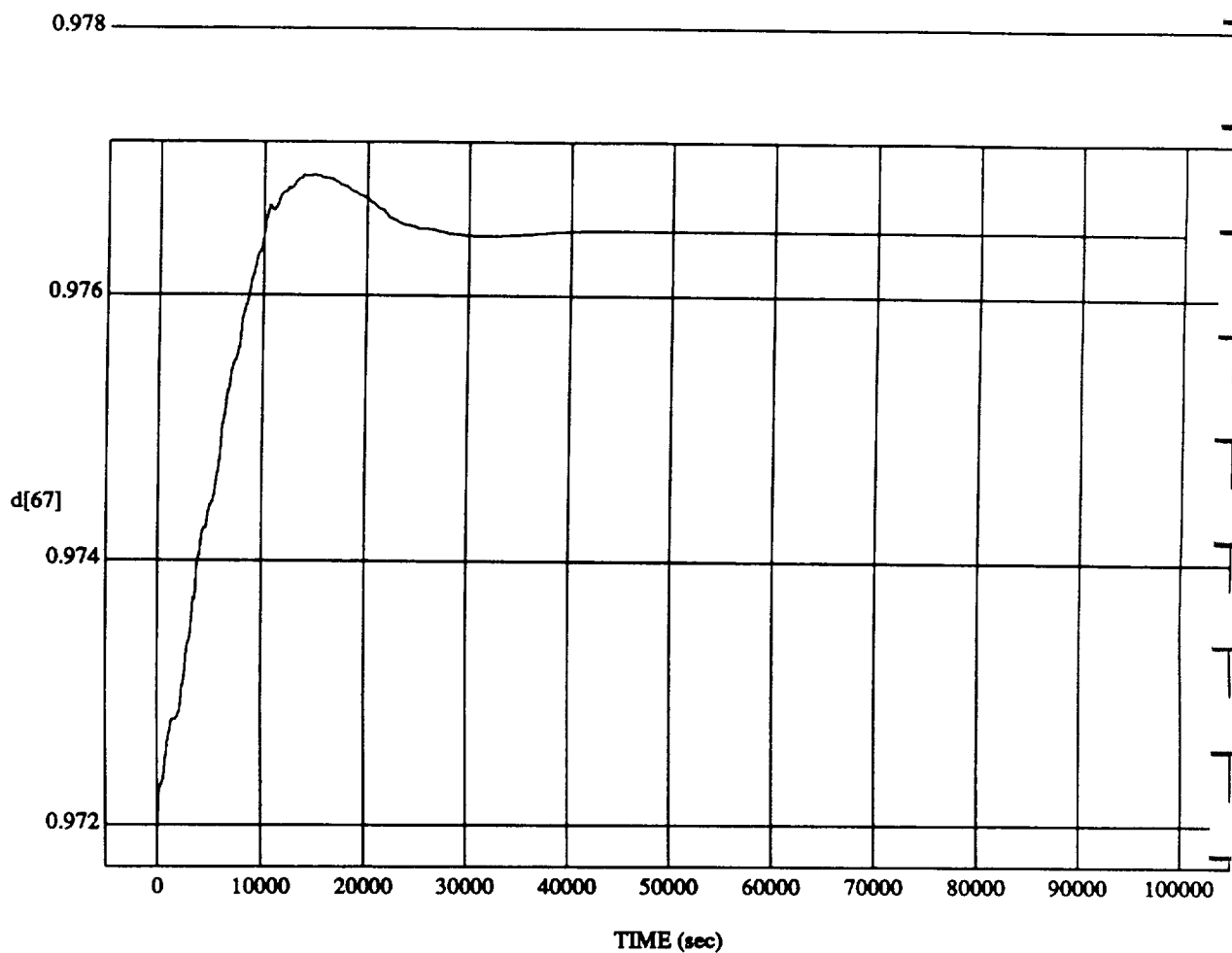
d[66] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

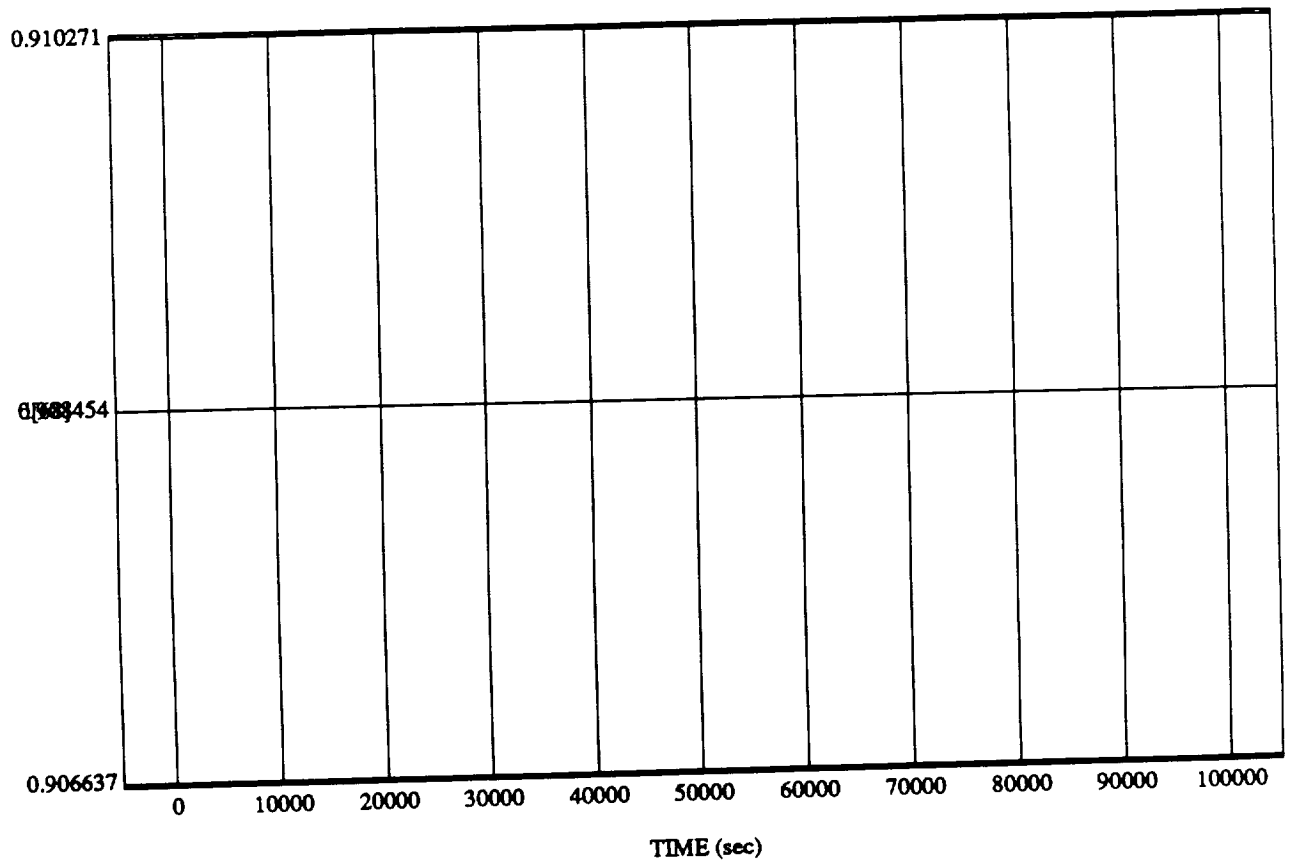
d[67] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.lean2  
DATA SAMPLING FREQUENCY: 0.005 Hz

SIMULATION APPLICATION: F's & D's Updated By Rule Strength - 8 July 1992

d[68] vs TIME  
RUN: -45 Pitch, -45 Yaw, -45 Roll Attitude Hold



MODULE: ORB\_FUZZ\_BATCH.learn2  
DATA SAMPLING FREQUENCY: 0.005 Hz

